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Factor Mobility and Heterogeneous Labour in Computable General Equilibrium Modelling

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Declaration

I hereby declare that I have completed the dissertation independently, and this research is original. I have not been supported by a commercial agent in writing this dissertation. Additionally, no aids other than the indicated sources and resources have been used. Furthermore, I assure that all quotations and statements that have been inferred literally or in a general manner from published or unpublished writings are marked as such. This work has not been previously used neither completely nor in parts to achieve any other academic degree.

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Abbreviations

CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CGE	Computable General Equilibrium
IDF	Israeli Defence Forces
OECD	Organization for Economic Co-operation and Development
PCBS	The Palestinian Central Bureau of Statistics
SAM	Social Accounting Matrix
WTO	World Trade Organisation

Summary

The representation of labour markets in Computable General Equilibrium (CGE) models is characterised by a trade-off between data representation and data availability. Models are by definition abstract and simplified pictures of the real world: as a map of scale 1:1 does not help to find an unknown destination, a model which perfectly depicts the real world would hardly help to analyse adjustment effects of policy changes or macroeconomic shocks. When the analysis is focused on distributional issues, it seems obvious that such an analysis can only be based on models that differentiate at least more than one household group. Household groups characteristically differ in factor endowment and since factor income– besides price effects – is a main determinant of welfare analysis, the specification of labour markets crucially determines the analysis. There are mainly two possibilities to specify the labour market in a CGE model: First, the labour market can be set up as competitive market with perfect substitutability between individual workers on that market. With this setup, wages must be equal among labour types and sectors because every difference in wages provokes adjustments, which finally equalise wages again. In contrast, data reports typically significant wage differences between labour types that can only originate from imperfect labour markets. Thus, the second option is to depict these wage differences by imperfect substitutability of individual workers in the production process. But data on substitution possibilities of labour demand between different labour types is weak and estimations of substitution elasticities are in most of the cases not available.

Meanwhile, in the real world, wages differ in various dimensions and in models labour types are typically differentiated by age, gender, skill level or occupation. When differentiating labour types within these dimensions, wage differences become possible and can be explained by transformation limitations between characteristics: e.g., wage differences between female and male workers are originating from the fact that female workers cannot become male workers. This differentiation has the effect that in most of the models, transformation between the characteristics of a dimension is no longer possible and workers stay in a specific labour type. Typically labour types are not differentiated by sector of employment and, thus, are assumed homogeneous amongst sectors. Movement of workers between sectors seems possible; nevertheless, data reports partly huge wage differences between different sectors of an economy. As a solution, CGE models typically include an efficiency parameter which allows calibrating the model according to the data, but the model assumes still homogeneous labour which should be priced equal. Thus, the efficiency parameter does not economically explain the existence of these wage differences.

Against this background, this thesis develops a comprehensive framework to model imperfect mobility in CGE models. First, the article on ‘Relaxing Israeli Restrictions on Labour: Who Benefits?’ introduces a single country CGE model for Israel with a detailed depiction of the labour market and a nested Constant Elasticity of Substitution (CES) production process. Based on this model, the second article on ‘Factor Mobility and Heterogeneous Labour’ introduces imperfect mobility between sectors with a migration function. It furthermore develops the possibility to change between sector and factor specific productivity, which is used to estimate productivity effects from factor reallocation. This theoretical approach is applied in the third article on ‘Labour market flexibility and costs of adjustment' to analyse the macroeconomic costs of intersectoral labour reallocation found in several empirical studies.

The thesis concludes that nested factor demand is useful to depict heterogeneity of factors. A main critic to this approach is the non-availability of required additional parameters, thus, substitution elasticities are mostly based on educated guesses instead of empirically estimates. However, careful sensitivity analyses show stable results for a wide range of elasticity values. The value of a substitution elasticity affects the results significantly only for extreme values or in combination with factor specific productivity, when productivity differences are huge, but this is more a matter of the productivity setup. Stronger than the value of the elasticity, the nesting structure and nesting hierarchy seem to matter for the model outcomes.

When labour moves from less to more productive sectors, an economy experiences a de facto increase in labour endowments, which is an important part in the explanation of economic growth. Empirical evidence suggests, however, that labour migrating between sectors experiences wage losses and that labour types are not perfectly mobile across sectors. Neglecting factor reallocation costs and factor specific productivity in CGE-modelling might overestimate the size of potential adjustments in the labour market as a response to exogenous shocks and, thus, affect simulation results; this is the research question in the second article. Productivity effects from labour reallocation are an important driver for model outcomes, macroeconomic results change completely in the second article when excluding them. The productivity effects are larger the more reallocation takes place, and the higher the mobility of labour is assumed. They depend also on the size of differences in sectoral wages. The relevance of productivity effects for model outcomes indicate that the assumption of full mobility might overestimate positive macroeconomic effects accruing, e.g., from trade liberalisation.

Several empirical studies show that workers, who change sectors, can experience large and persistent wage losses. Responsible for these losses are primarily two effects: lower incomes during unemployment, and lower wages upon reemployment. Neglecting these reallocation costs overestimates the possibility of adjustment for an economy as well as the welfare benefits of policy reforms. The third article shows, that costs of labour reallocation, which decrease labour mobility, matter on the macroeconomic level, affect the whole economy and especially income distribution. Workers who would migrate but are hindered due to the related costs, are the ones to lose the most. Provided the adjustment leads to inflow of workers in the more productive sectors of an economy, the losers are relative low waged workers in the less productive sectors and the income gap widens.

This thesis presents a comprehensive and flexible framework to introduce imperfect factor markets in CGE models. Labour mobility between labour types is controlled by migration functions where the degree of mobility is controlled by elasticities that govern the responsiveness of migration to changes in relative wages. Finally, the model provides the user with three additional instruments to control the operation of labour markets. First, the user can control the stock flow relationship for each labour type, e.g., does a migrating worker keep her productivity from the initial activity, adopt that of the destination activity or something in between; second, the user controls the flexibility of the labour market by setting the migration elasticities between activity blocks; and third, the setting of adjustment parameters determines the (assumed) costs of migrating. The analysis of productivity effects and costs of factor reallocation emphasises the relevance and influence of labour market specifications on model outcomes. Thus, this thesis sets the base for a careful setup and test of labour market assumptions applied in CGE models.

Zusammenfassung

Die realistische Wiedergabe von Daten auf der einen Seite, sowie die Verfügbarkeit von Daten auf der anderen, bilden einen Grundkonflikt bei der Abbildung von Arbeitsmärkten in allgemeinen Gleichgewichtsmodellen (CGE-Modellen). Modelle sind per Definition abstrakte und vereinfachte Bilder der realen Welt: Wie eine Landkarte mit dem Maßstab 1:1 nicht weiterhilft, ein unbekanntes Ziel zu finden, wird ein Modell, welches die Realität perfekt wiedergibt, kaum dabei helfen, Anpassungseffekte und Auswirkungen von politischen Entscheidungen oder makroökonomischen Schocks zu analysieren. Wenn die Analyse auf Verteilungswirkungen abzielt, scheint es naheliegend, dass eine solche Analyse nur mit Modellen durchgeführt werden kann, die mehrere Haushaltsgruppen unterscheiden. Haushaltsgruppen unterscheiden sich typischerweise in ihrer Faktorausstattung und damit in ihrem Faktoreinkommen. Faktoreinkommen ist – neben Preiseffekten – eine der Haupteinflussgrößen in der Wohlfahrtsanalyse, damit beeinflusst die Darstellung der Arbeitsmärkte die Analyse entscheidend. Es gibt vor allem zwei Möglichkeiten einen Arbeitsmarkt in einem CGE-Modell darzustellen: Erstens kann der Arbeitsmarkt als Wettbewerbsmarkt aufgefasst werden, in welchem die Arbeitskräfte perfekt substituierbar sind. In einem solchen Wettbewerbsmarkt müssen die Löhne von verschiedenen Arbeitergruppen und Sektoren einheitlich sein, denn jeder Lohnunterschied verursacht Anpassungseffekte, welche letztendlich wieder zu einem einheitlichen Lohnniveau führen. Im Gegensatz dazu weisen Arbeitsmarktdaten typischerweise deutliche Lohnunterschiede aus, welche nur aufgrund unvollkommener Arbeitsmärkte entstehen können. Somit, um diesen Lohnunterschieden gerecht zu werden, ist die zweite Möglichkeit der Abbildung von Arbeitsmärkten eine unvollkommene Substituierbarkeit individueller Arbeitskräfte im Produktionsprozess. Der Nachteil dabei ist, dass bei diesem Ansatz deutlich mehr Parameter benötigt werden, die kaum oder nicht verfügbar sind, wie zum Beispiel Informationen über die Substituierbarkeit verschiedener Gruppen von Arbeitern.

Währenddessen unterscheiden sich Löhne in der Realität in verschiedensten Dimensionen, Arbeitskräfte werden daher in Modellen üblicherweise anhand von Alter, Geschlecht, Qualifikation oder Beruf kategorisiert. Wenn Arbeiter in diesen Dimensionen kategorisiert sind, werden Lohnunterschiede möglich und sind durch beschränkte Transformationsmöglichkeiten zwischen den Ausprägungen der Dimension erklärbar: z.B. kann sich eine weibliche Arbeiterin kaum in einen männlichen Arbeiter verwandeln und Lohnunterschiede können somit nicht durch Transformation in die andere Kategorie ausgeglichen werden. Die Differenzierung anhand verschiedener Ausprägungen hat zur Folge, dass in den meisten Modellen keine Transformation zwischen den Ausprägungen mehr möglich ist und Arbeiter somit in einer spezifischen Kategorie verbleiben. Normalerweise werden Arbeiter nicht anhand des Beschäftigungssektors kategorisiert, daher wird implizit angenommen, dass Arbeiter homogen über Sektoren sind. Bewegungen von Arbeitern zwischen Sektoren scheinen durchaus möglich, trotzdem findet man in den Daten teilweise große Lohnunterschiede zwischen Sektoren. Aus diesem Grund haben CGE-Modelle typischerweise einen Effizienz-Parameter, der es erlaubt, das Modell im Sinne der Daten zu kalibrieren. Trotzdem basiert der Arbeitsmarkt des Modells immer noch auf der Annahme von homogener Arbeit, welche einen einheitlichen Lohn erhalten sollte und der Effizienz-Parameter erklärt damit nicht die Existenz dieser Lohnunterschiede.

Vor diesem Hintergrund entwickelt diese Dissertation eine umfassende Struktur zur Modellierung von unvollständiger Mobilität in CGE-Modellen. Der erste Artikel, 'Relaxing Israeli Restrictions on Labour: Who Benefits?', stellt ein Ländermodell für Israel vor, welches den Arbeitsmarkt detailliert abbildet und einen Produktionsprozess beinhaltet, der sich über mehrere Ebenen erstreckt und diese Ebenen mit CES-Funktionen (konstante Substitutions-Elastizitäten) verbindet. Aufbauend auf diesem Modell entwickelt der zweite Artikel, 'Factor Mobility and Heterogeneous Labour', unvollkommene Mobilität zwischen Sektoren, welche mit einer Migrations-Funktion eingeführt wird. Zudem entwickelt der Artikel die Möglichkeit zwischen sektorspezifischer und faktorspezifischer Produktivität zu wechseln, was es ermöglicht, Produktivitätseffekte von Faktorreallokation zu schätzen. Dieser theoretische Ansatz wird im dritten Artikel, 'Labour market flexibility and costs of adjustment', angewandt, welcher die makroökonomischen Kosten der Reallokation von Arbeitern zwischen Sektoren analysiert, deren Existenz in empirischen Studien nachgewiesen ist.

Die Dissertation kommt zum Schluss, dass eine gruppierte, hierarchische Faktornachfrage nützlich ist, um die Heterogenität von Faktoren abzubilden. Ein Hauptkritikpunkt mit diesem Ansatz ist die fehlende Verfügbarkeit der benötigten zusätzlichen Parameter. Substitutionselastizitäten basieren daher oft auf Erfahrungswerten, anstatt empirischen Schätzungen. Systematische Sensitivitätsanalysen zeigen jedoch stabile Modellergebnisse für eine große Bandbreite von Elastizitätswerten. Der Wert einer Substitutionselastizität beeinflusst die Ergebnisse signifikant nur für Extremwerte oder in Kombination mit faktorspezifischer Produktivität, wenn Produktivitätsunterschiede groß sind, was jedoch ein Problem der Produktivitätsspezifikation ist. Von größerer Bedeutung für Modellergebnisse als der gewählte Wert der Elastizitäten, ist die Struktur und Hierarchie der Ebenen.

Wenn Arbeiter von weniger produktiven zu produktiveren Sektoren wechseln, erfährt eine Ökonomie faktisch einen Anstieg des Arbeitskräftepotentials, was einen wichtigen Anteil bei der Erklärung von volkswirtschaftlichem Wachstum spielt. Empirische Arbeiten legen nahe, dass Arbeiter, welche ihre Beschäftigungssektoren wechseln, Lohnverluste erleben und daher nicht vollkommen mobil zwischen Sektoren sind. Die Vernachlässigung von Reallokationskosten und faktorspezifischer Produktivität in CGE-Modellen kann zur Überschätzung des Anpassungspotentials nach einem exogenen Schock führen und somit Simulationsergebnisse beeinflussen; dies ist die Forschungsfrage im zweiten Artikel. Die Ergebnisse zeigen, dass Produktivitätseffekte von Arbeitsreallokation ein wichtiger Treiber für Modellergebnisse sind. Makroökonomische Ergebnisse drehen sich in Artikel zwei komplett um, wenn Produktivitätseffekte ausgeschaltet werden. Diese Produktivitätseffekte sind größer, je mehr Reallokation stattfindet und je höher die Möglichkeit der Mobilität angenommen wird. Die Relevanz von Produktivitätseffekten für Modellergebnisse zeigt, dass die Annahme der vollständigen Mobilität positive makroökonomische Effekte, z.B. von Handelsliberalisierung, überschätzt.

Einige empirische Studien zeigen, dass Arbeiter, welche ihren Beschäftigungssektor wechseln, große und andauernde Lohnverluste erfahren. Verantwortlich für diese Verluste sind vor allem zwei Effekte: geringeres Einkommen während Arbeitslosigkeit und geringere Löhne in der neuen Arbeitsstelle. Die Vernachlässigung dieser Kosten überschätzt die Anpassungsfähigkeit einer Ökonomie, sowie positive Wohlfahrtseffekte von Politikreformen. Der dritte Artikel zeigt, dass die

Kosten der Arbeitsreallokation, welche Arbeitsmobilität verringern, auch auf makroökonomischer Ebene Bedeutung haben und insbesondere Auswirkungen auf die Einkommensverteilung haben. Arbeiter, welche aus einem Sektor abwandern würden, durch die damit verbundenen Kosten jedoch daran gehindert werden, sind diejenigen, welche am meisten betroffen sind. Vorausgesetzt, dass die Anpassung in Richtung zu den produktiveren Sektoren der Ökonomie führt, sind die Verlierer die relativ geringer entlohnten Arbeiter in den weniger produktiven Sektoren und die Einkommensschere weitet sich.

Die Dissertation präsentiert einen umfassenden und flexiblen Rahmen, um unvollkommene Faktormärkte in CGE-Modellen abzubilden. Arbeitsmobilität zwischen verschiedenen Kategorien von Arbeitern wird von einer Migrations-Funktion gesteuert, wobei die Stärke der Mobilität von Migrationselastizitäten beeinflusst wird, welche die Sensitivität der Migration hinsichtlich relativer Lohnveränderungen bestimmen. Das Modell bietet dem Nutzer schließlich drei zusätzliche Instrumente, um den Arbeitsmarkt zu kontrollieren: Erstens kann der Nutzer den Produktivitätsfluss für jede Arbeiter-Kategorie kontrollieren, z.B. ob ein Arbeiter seine alte Produktivität behält, die des neuen Sektors annimmt oder diese nur teilweise annimmt. Zweitens kann der Nutzer mit Hilfe der Migrationselastizitäten die Flexibilität des Arbeitsmarktes kontrollieren; und drittens bestimmen zusätzliche Anpassungs-Parameter die (angenommenen) Kosten der Migration. Die Analyse von Produktivitätseffekten und Faktor-Reallokationskosten machen die Relevanz und den Einfluss von Arbeitsmarktspezifikationen auf Modellergebnisse deutlich. Diese Arbeit bildet eine Basis für eine sorgfältige Konfiguration und Überprüfung von Annahmen, welche in CGE-Modellen für Arbeitsmärkte zum Einsatz kommen.

Main Part

I. Introduction

Computable General Equilibrium (CGE) models exist in various levels of aggregation and the assumptions on and simplifications of behavioural relationships vary strongly. There are CGE models ranging, e.g., from the simple 1-2-3 model developed by Devarajan *et al.* (1997), with one country, two producing sectors and three goods, to the MIRAGE model, which includes a poverty module with more than 50 household groups per region, multiple regions and up to 57 sectors (Bouet *et al.*, 2011). Other models, such as GTAP (Hertel, 1997), focus on trade and depict factor markets and domestic agents rather aggregated, but illustrate a very detailed view on trade relationships and trade partners, i.e., the latest GTAP 8 database incorporates detailed trade data for 129 regions. Thus, the level of abstraction depends crucially on the research question to be analysed. The representation of factor markets in CGE models is characterised by a trade-off between representation of real world data, market structure and empirically validated behavioural parameters. Models are by definition abstract and simplified pictures of the real world: as a map of scale 1:1 does not help to find an unknown destination, a model, which perfectly depicts the real world, would hardly help to analyse adjustment effects of policy changes or macroeconomic shocks. When the analysis focuses on distributional issues, it seems obvious that such an analysis can only be based on models, which differentiate at least more than one household group. These household groups characteristically differ in factor endowment and since factor income is – besides commodity price effects – a main determinant to welfare analysis, the specification of labour markets crucially determines the analysis.

There are mainly two possibilities to specify the labour market in a CGE model: First, the labour market can be set up as a competitive market, with perfect substitutability between the individual workers and groups of workers (labour types) on that market. With this setup, wages must be equal among labour types and sectors, because every difference in wages provokes adjustments which finally equalise wages again. In contrast, the data typically reports significant wage differences between labour types that can only originate from imperfect labour markets. Thus, the second option is to depict these wage differences by imperfect substitutability of individual workers in the production process. But data on substitution possibilities of labour demand between different labour types is weak and estimations of substitution elasticities are in most of the cases not available. Boeters and Savard (2013), which review the modelling of labour markets in CGE models, therefore see a plausible default in the assumption of perfect substitutability in labour demand. According to Boeters and Savard (2013), demand differentiation is only justified, when there is evidence that wages do not move in parallel.

Meanwhile, in the real world, wages differ in various dimensions: typically labour types are differentiated by age, gender, skill level or occupation. When differentiating labour types within these dimensions, wage differences become possible and can be explained by transformation limitations between characteristics: e.g., wage differences between female and male workers are originating from the fact, that female workers cannot become male workers[1]. This differentiation has

[1] Wage differences between male and female workers are an empirical fact, why and if the gender matters in the production process is controversially discussed.

the effect, that, in most of the models, transformation between the characteristics of a dimension is no longer possible and workers stay in a specific labour type. In perfectly competitive markets, only heterogeneous productivities can explain the existence of wage differences (Bourguignon and Bussolo, 2013). To stay economically consistent, if wage differences are not based on productivities, the labour market cannot be perfectly competitive. Market imperfections might originate from wage discrimination against parts of the labour market or the existence of groups of workers, who can secure non-competitive advantages in some areas (Bourguignon and Bussolo, 2013). In both cases, if labour types earn different wages due to heterogeneous productivities and due to imperfect markets, labour types seem to be imperfect substitutes in the production process.

In CGE models, labour types are usually not differentiated by sector of employment and thus are assumed homogeneous amongst sectors. Movement of workers between sectors is possible; nevertheless, data reports partly huge wage differences between different sectors of an economy. To reflect these wage differences in the model, CGE models typically include an efficiency parameter which allows calibrating the model according to the data, but the model assumes still homogeneous labour, which should be priced equal. Thus, the efficiency parameter does not economically explain the existence of these wage differences.

Against this background, this thesis develops an alternative approach to include heterogeneous labour in a CGE framework. To this end, imperfect mobility is implemented using migration functions, where workers migrate between different sector blocks of production. Migration functions have been used to depict migration between countries or regions by McDonald and Thierfelder (2009), with workers migrating to a pool and from that pool. This study extends the migration function approach, by defining migration bilaterally between different sector blocks of the economy. Based on this approach, the thesis analyses the relevance of heterogeneous labour for model outcomes, i.e., it estimates productivity effects from factor reallocation and analyses macroeconomic costs of intersectoral labour reallocation. For this purpose, the model is extended to allow to specify productivity as sector-specific or factor-specific. The thesis is based on three articles, which form a cumulative dissertation. These articles are developed in the framework of the trilateral project on '*The Economic Integration of Agriculture in Israel and Palestine'* funded by Deutsche Forschungsgemeinschaft (DFG). Article 2 (section III) focusses on the methodological contribution, while article 1 (section II), which introduces the base model and database, and article 3 (section IV) are more applied.

The first article '*Relaxing Israeli Restrictions on Labour: Who Benefits?*', published in *Economic Modeling*, introduces imperfections on the Israeli labour market with a system of nested Constant Elasticity of Substitution (CES)-functions in a single country CGE model, adapted to a Social Accounting Matrix (SAM) of Israel for the year 2004. Imperfect substitutability in labour demand is assumed for different dimensions, i.e., skill level, ethnicity, gender and occupation. The study evaluates the effects of reducing movement and access restrictions between Israel and the West Bank: Palestinian workers have been employed in low-skilled jobs in Israel for decades. The second Intifada, starting in 2000, severely increased border restrictions and sharply reduced employment possibilities for Palestinians in Israel, increased unemployment and reduced income in the West Bank.

The second article, *'Factor Mobility and Heterogeneous Labour',* submitted to Labour Economics, establishes a framework in which factors are non-homogeneous among sectors. Reflecting the data for the Israeli labour market, which reports huge wage differences between sectors and for notionally the same labour type, factors are additionally differentiated according to sectors. A migration function is implemented to allow for movements between sectors dependent on relative wages. When assuming a perfectly competitive market with no distortions, the wage differences between sectors result from productivity differences, which raises the question whether these heterogeneous productivities are related to the sector of employment or the factor itself. If labour productivity is modelled as sector specific and labour moves from less to more productive sectors, an economy experiences a *de facto* increase in labour endowments, which affects simulation results. Separating the impacts of implicit increases in labour endowments from other impacts arising from labour reallocation is therefore important for result interpretation. Two scenarios are run in order to analyse the size and relevance of the productivity effect: the first scenario causes labour to move from less to more labour productive industries, the second scenario induces movement of labour from more to less productive industries

The third article *'Labour Market Flexibility and Costs of Adjustment'* submitted to the Journal of Policy Modelling applies the methodology developed in the second article. Findings of the empirical literature on reallocation costs are considered in a CGE framework: not only is the mobility of labour between sectors assumed imperfect, but there are additional adjustment costs originating from labour movement. Neglecting these reallocation costs overestimates the size of labour movements and therefore the possibility of adjustment for an economy as well as the welfare benefits of policy reforms. In the light of the Palestinian-Israeli conflict, the study analyses, how the existence of labour reallocation costs for movement between sectors is influencing welfare effects accruing from a calming down of tensions resulting in increasing employment of Palestinians in Israel.

The thesis concludes with a general discussion and synthesis of the three articles. For the description of technical details is rather tight in journal articles, a detailed technical appendix on database, base model and model adjustments complements the main part of the thesis.

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II. Relaxing Israeli Restrictions on Labour: Who Benefits?

Dorothee Flaig, Khalid Siddig, Harald Grethe, Jonas Luckmann and Scott McDonald

This chapter consists of the correspondent article which is published in *Economic Modelling*. Any reference to this chapter should be cited as: *Flaig, D., Siddig, K., Grethe, H., Luckmann, J and McDonald, S. (2013). Relaxing Israeli Restrictions on Labour: Who Benefits? Economic Modelling, 31: 143-150.*

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Abstract

Palestinian workers have been employed in low-skilled jobs in Israel for decades. The second Intifada, from 2000, increased border restrictions severely and sharply reduced employment possibilities in Israel for Palestinians, increased unemployment and reduced income in the West Bank. Israeli employers responded by increasing the number of foreign workers, mostly from Asia. Growing unemployment among Israeli unskilled workers caused Israel to impose quotas on the employment of foreigners. This study evaluates the effects of reducing movement and access restrictions between Israel and the West Bank. The study uses a single country computable general equilibrium model, adapted to a Social Accounting Matrix of Israel for the year 2004, to simulate the effects of different Israeli labour policy regimes and to identify the inter sectoral, whole economy and distributional implications.

Keywords:

International Migration, Immigrant Workers, Labour Economics, Computable General Equilibrium Models, Israel, Palestine

JEL-Classification:

C68, F22, J61, J00

II.1. Introduction

Palestinian workers commute to Israel on a day-to-day basis for, predominantly, employment in the agricultural and construction industries where wage rates exceed those in the West Bank and Gaza. By 1999 Israel was the largest employer of Palestinian workers, with 23% of the employed Palestinians working in Israel and its settlements (PCBS, 2010), but this had fallen to 8% of Palestinian employees by 2004 which had inevitable adverse consequences for employment and income in Palestine (PCBS, 2010). Fluctuations in the numbers of Palestinians working in Israel follow political relations between Israel and the Palestinian Territories: after the election of the Palestinian Authority in 1995 employment increased until the outbreak of the second Intifada, in 2000, when employment fell sharply. The Israeli labour market responded to these fluctuations by increasing the number of foreign workers[2], mostly from Asia. More recently tighter quotas have been imposed on foreign workers following increases in the unemployment rates of Israeli low and unskilled workers.

The Palestinian Territories, the West Bank and the Gaza Strip, are *de facto* economically separate[3], have different economic and social characteristics, are ruled by different parties, and experience different treatment from Israel. Unemployment in the West Bank decreased from 28.2% in 2002 to 17.8% in 2009, but remained high in the Gaza Strip, 38.6% in 2009, (see Figure II.1), with, in 2010, no cross-border workers from Gaza but about 14.0% of West Bank workers in Israel (PCBS, 2010). This study focuses only on the labour markets of the West Bank and Israel, since the bar on workers from the Gaza Strip is unlikely to be lifted soon.

This study estimates the potential benefits accruing to both economies from reducing labour movement restrictions between Israel and the West Bank. Such a policy change will impact differently on different industries in Israel and will have whole economy implications; hence the study uses a computable general equilibrium (CGE) model (STAGE) that has been adapted for this analysis. The data employed are provided by a Social Accounting Matrix (SAM) for Israel in 2004 (Siddig *et al*., 2011) developed for this study.

The next section provides an overview of the Israeli and Palestinian labour markets, while section 3 describes the CGE model, its extension and the Israeli SAM, and additional data. Section 4 defines the scenarios analysed and presents and discusses the results. The conclusions and potential policy implications are discussed in the final section.

II.2. Labour Markets in the West Bank and Israel

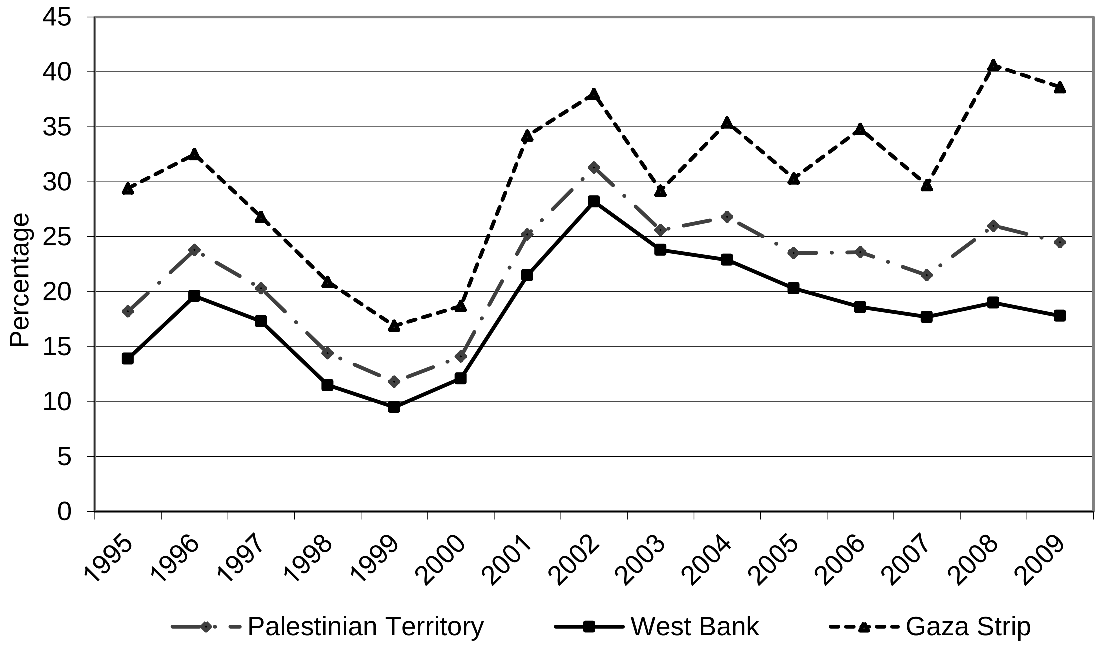
II.2.1. The West Bank Labour Market

The West Bank labour force is fast growing. In the 15 years to 2009 it nearly doubled, from 358 to 643 thousand (PCBS, 2010); largely reflecting the demographic profile but the potential for increase is large due to the relatively low participation rate, 43.8%, that derives from the low participation

[2] Palestinians are not considered foreign workers.
[3] Less than 1.0% of West Bank workers have been employed in Gaza since 1995 and vice versa.

rate of women (17.4%).[4] Unemployment declined strongly in the late 1990s (Figure II.1) during a period of high economic growth. But unemployment increased with the outbreak of the second Intifada in 2000, which resulted in the closure of the Israeli-Palestinian border and the establishment of restrictions on movement, e.g., checkpoints and road barriers within the Palestinian Territories, and a sharp reduction in the employment of Palestinians in Israeli and its settlements (PCBS, 2005). Unemployment further increased with the contraction of the Palestinian economy, although since 2003 unemployment has fallen primarily due to employment growth in the West Bank.

Figure II.1. Unemployment Rates in the Palestinian Territories (%, 1995-2009)



Source: Own compilation based on PCBS (2010).

Palestinian employment in Israel has long been substantial (Figure II.2), but access to the Israeli labour market by Palestinians is managed. In 1999 employment in Israel and its settlements accounted for 26% of West Bank workers, but this had declined to 13% by 2002; since then the number of Palestinians employed in Israel has doubled although it only accounted for 14% by 2009 due to the growth in the labour force (PCBS, 2010). Expansion of such employment has significantly increased national income and demand (Palestinian Ministry of Finance, 2009).

Palestinians are mainly employed in unskilled or low skilled jobs in Israel, where the wages are at least 70% higher than the average wage in the West Bank (Bank of Israel, 2010a; PCBS, 2010). Compared to neighbouring countries, the wage level in the West Bank is relatively high (Aix-Group, 2007), which may be due to the possibility of employment in Israel, which raises the reservation wage (Bulmer, 2003).

[4] In the Gaza Strip, the labour force participation rate was 37.6% in 2009.

II.2.2. Structure of the Labour Force in Israel

During the second Intifada domestic demand stagnated in Israel and unemployment increased, peaking at 10.6% in 2003. After 2003 the Israeli economy grew rapidly and wages and employment rates increased so that by 2006 there was 'full employment in Israel' (Bank of Israel, 2010a) with the lowest unemployment rate (6.1%) in two decades and the highest level (56.5%) of labour force participation. Since 2009 unemployment has slightly increased; mainly due to declining employment in industries that intensively use low skilled labour.

Israeli low and unskilled workers compete with foreign (non-Palestinian) and Palestinian workers in the labour market. Israeli workers rarely take employment below the minimum wage (OECD, 2010c), while weak enforcement of the minimum wage law allows foreign and Palestinian workers to be employed below the minimum wage (Bank of Israel, 2010b; OECD, 2010c). Moreover Israelis who serve in the Israeli Defence Forces (IDF) are supported with privileges in the labour market (OECD, 2010c). Since Arab Israeli's rarely serve in the IDF this results in Jewish and Arab Israeli's being differentiated in the labour market.[5] The segmentation of the labour market implied by these institutional arrangements is confirmed by the wage rates implied by the data.

Table II.1. Different Reporting on Wages for Palestinian Workers in Israel, 2005

Minimum wage in Israel	Wages according to OECD publications[a]	Wages according to PCBS and Bank of Israel publications	Average wage in the West Bank (PCBS)
20 NIS/hour[d]	18 NIS/hour[a]	16 NIS/hour[d]	9 NIS/hour[d]
160 NIS/day	144 NIS/day[d]	127 NIS/day	74 NIS/day
3,335 NIS/month	-	2,772 NIS/month[b]	1,739 NIS/month[c]

[a] Association of Contractors and Builders in Israel (2009) as cited in OECD (2010c). [b] calculated with 22 days. [c] calculated with 23.6 days in West Bank. [d] calculated with 8 working hours per day.

Sources: OECD (2010c), PCBS (2011), Bank of Israel (2010a).

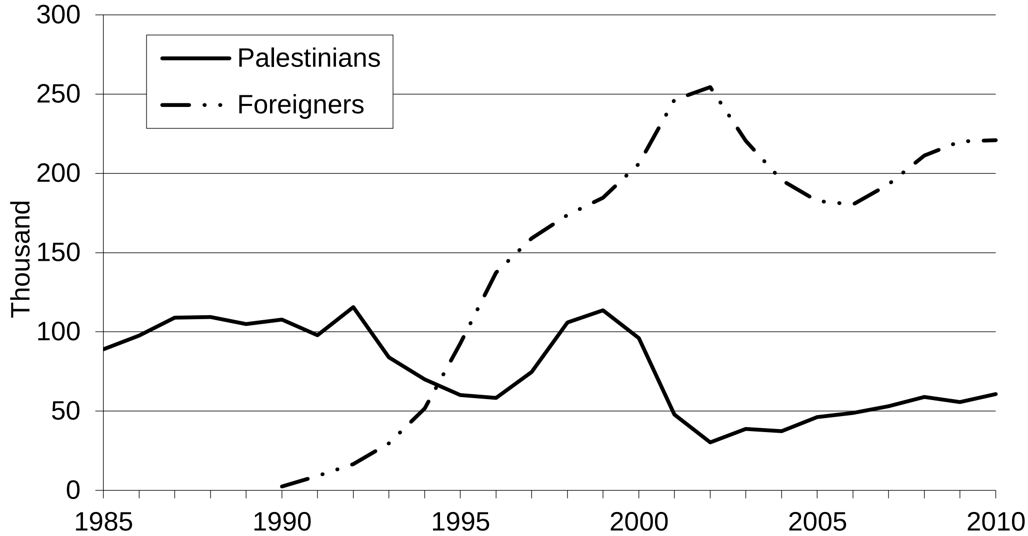
The wages in Israel range from 127 NIS per day to 160 NIS per day, the minimum wage (Table II.1). Palestinian workers can earn between 70 and 110% more on the Israeli unskilled/low skilled labour market than the average wage on the West Bank labour market. The wage rates for foreigners on the Israeli labour market are higher than for Palestinians (OECD, 2010c); employers have to pay higher social contributions and fees for foreign workers, although Palestinians receive subsidised transportation. Consequently there are strong incentives for Palestinians to seek employment in Israel.

Since 1990 Israel has increasingly turned to foreign workers with the relative and absolute participation of Palestinians declining with the tensions in the early 1990s and again after 2000. There was a recovery after the election of the Palestinian Authority in 1995 and since 2003 there has

[5] Certain Israelis are exempted from service in the IDF on religious grounds.

been a slow increase, but the number of Palestinian workers is still well below the levels in the 1980s (Figure II.2).

Figure II.2. Palestinian and Foreign Workers in Israel (in thousands, 1985-2010)



Source: Own compilation based on Bank of Israel (2011)

Three Israeli industries are highly dependent on non-Israeli (Palestinians and foreigners) workers: agriculture, construction, and homecare. In 2008, 30% of all employees in construction and 37% of all employees in agriculture were non-Israeli (Bank of Israel, 2009). In these industries wages are low and employers have difficulties recruiting Israelis.

After 1993 the flow of Palestinians to Israel became irregular due to access restrictions that were determined by security, not economic, concerns. Changing security procedures increased uncertainty of whether the workers would be able to reach their workplace, even for those holding permits. This situation affected both employers and employees negatively (Aix-Group, 2007).

Since 1990 workers from abroad, mainly Asia, have been allowed to work in Israel on renewable three monthly work permits as employers lobbied to raise the number of foreign workers in Israel. For 10 years, the number of foreign workers in Israel increased rapidly (Figure II.2). Despite the number of permits issued remaining almost constant since 1995, with approximately 60 thousand permits released annually (Bank of Israel, 2008; OECD, 2010c), and quotas on foreign labour in agriculture and construction, the number of foreigner workers has increased, mainly due to 'illegal' workers (people who stay in Israel after their working permit ended). A period of stricter enforcement of work permits reduced the number of foreign workers in the early 2000s but since 2005 the number has been rising.

The short-run elasticity of Israeli demand for Palestinian labour in the late 1980s was estimated at between -1 and -2 (Angrist, 1996); this study also provided strong evidence that decreasing Palestinian labour supply in Israel significantly increased wages Israeli employers pay, especially for low-skilled workers in construction and agriculture. Since 1990 the presence of large numbers of foreign workers has changed the situation. The effects of foreign workers on the employment situation for Palestinian cross-border workers was analysed in an empirical study by Aranki and Daoud (2010) with data covering a period from 1999 to 2003. Their findings indicate that it is less the presence of foreigners but rather movement obstacles that restrict Palestinians crossing the border for work, which significantly limit Palestinians' employment opportunities.

Several studies analyse the impact of foreign workers on wages of native workers. Chao and Yu (2002) use a simple two-sector general equilibrium model to examine why immigration policies typically favour skilled immigrants and discriminate against unskilled immigrants. They distinguish between a non-tradable services industry, which is skilled labour intensive, and a low-skilled labour intensive industry producing tradable products, where the non-traded sector is governed by imperfect competition. Their findings indicate that immigration of skilled workers is welfare enhancing, while the immigration of unskilled workers can reduce the host country's welfare. Immigration of skilled workers leads to an expansion of the skilled labour intensive services industry and to falling prices. Thus the inflow of skilled workers increases welfare by shrinking the existing distortion in the services industry via an increase in the output of this industry; immigration of unskilled workers has the opposite effects. According to Carter (2005) the competition for jobs is between native and foreign workers, hence their substitutability is crucial for welfare effects from immigration. This theoretical study, which uses a rather aggregated migration model, analyses competition across segmented labour markets, and demonstrates that if there are more migrants in a country the number of jobs for migrants increases, migrants' wages are lowered and income for the host country from capital and labour increases. But if migrants start to move into jobs previously occupied by native workers, host-country labour may be hurt by falling wages and increasing unemployment. In this regard it is not the number of migrants which may harm native workers, but the number of jobs, which is available for the native workers. Regarding Israel the labour market is rather segmented between Israelis and immigrants, for migrants are dominantly working in low-skilled jobs in agriculture and construction, in which Israelis are hardly willing to work.

II.3. Analytical Framework and Data

II.3.1. Main Features of the STAGE Model

This study uses an augmented version of the single country Computable General Equilibrium (CGE) model STAGE (McDonald, 2009). STAGE is a Social Accounting Matrix (SAM) based model with a mix of non-linear and linear relationships governing the behaviour of the model's agents. Households maximise utility subject to preferences represented by Stone-Geary utility functions. They consume 'composite' products that are constant elasticity of substitution (CES) aggregates of domestic and imported products. Domestic and imported products are modelled as imperfect substitutes, following Armington (1969), where the relative price determines the optimal ratio of domestic and imported product consumption. Israel is assumed to be a small country in the world market; therefore world market prices for imports and exports are fixed.

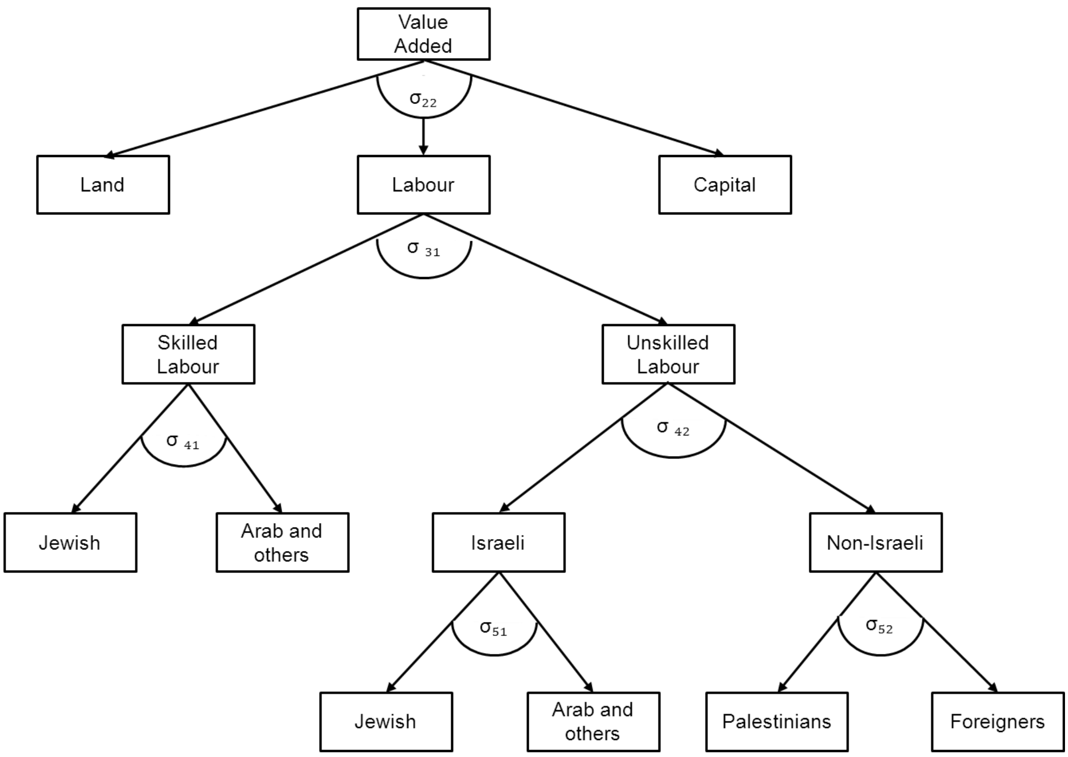
Domestic production is modelled as a two stage production process with either Leontief or CES technologies applied. At the first stage, intermediate input and value added generate the output of each industry. At the second stage the use of intermediate inputs is in fixed proportions using Leontief technology. CES technology is used at the second stage to form value added by primary production factors where the optimal ratio of factors is determined by relative prices.

Product demand consists of domestic demand and export demand. The distribution of domestically produced products among domestic demand and exports is governed by relative prices on these markets, using constant elasticity of transformation (CET) functions, which reflects imperfect product transformation.

II.3.2. Modelling of the Labour Market

The domestic production module is extended to use a five-level production process that better reflects the operation of the Israeli labour market. Aggregate value added is defined as a series of CES aggregates of (natural) primary inputs or aggregated (primary) inputs where the optimal combinations of these inputs are determined by relative input factor prices. At each level the model allows for the elasticities of substitution to be level and industry specific. Because of the lack of empirical evidence to calibrate the CES elasticities the base configuration of the model assumes that the elasticities are only level specific[6]; the sensitivity of the results to this assumption is tested by sensitivity analysis (see Section 4.2.3 below).

Figure II.3. Value Added Nesting



Source: own compilation.

Figure II.3 illustrates the value added nesting structure adopted for all activities. Since Palestinian and foreign labour are not represented in the skilled labour market in Israel only Israeli, Jewish and Arab & Other, skilled labour are available, and therefore aggregate skilled labour can only be sourced from

[6] The value of the elasticities ($\sigma_{i,j}$) are chosen as follows: derived from literature (Hertel, 1997) σ_{22}=0.8 and σ_{31}=1.5; good substitutability is assumed between Jewish and Arab Israeli groups as well as unskilled labour σ_{41}=σ_{42}=σ_{51}=4 and a very strong substitutability between Non-Israelis σ_{52}= 6.

different ethnically defined Israeli skilled labour (PCBS, 2005). Aggregate unskilled labour can be either Israeli or non-Israeli: this reflects the segmentation in the Israeli labour market that is reflected in the differences in wage rates (see Table II.1). As with skilled labour the Israeli unskilled labour aggregates are made up of Jewish and Arab & Other workers resident in Israel. The non-Israeli unskilled labour aggregates are made up of Palestinian and foreign unskilled labour, which reflects the fact that Palestinian and foreign unskilled labour are in 'direct' competition while, for instance, Jewish and Palestinian unskilled labour are in less 'direct' competition.

While all labour incomes for Palestinian labour are earned within Israel they work in Israel on a day to day basis and wages are remitted directly to households in the Palestinian Territories; hence they do not contribute to final demand within Israel.

Segmentation according to ethnicity within the categories of Israeli labour, skilled and unskilled, reflects the fact that wages differ substantially (see Section 3.3), such differences stem from various discriminating features of the Israeli labour market system. For example, there is recognition that in Israel ethnicity affects employment. This is partly due to service in the Israeli Defence Forces (IDF) (OECD, 2010a, b); Jewish Israelis (with the exemption of the religious Haredim) serve for two to three years in the IDF while Arabs generally do not serve. Those who serve in the IDF are supported with privileges in the labour market, which means that such supporting practices affect one population group more than the other (OECD, 2010c).

II.3.3. The Database

Few SAMs and CGE models have been developed for Israel. The first SAM for Israel was developed by Palatnik (2009) for 1995, which provides data on 18 industries and products and has a special focus on energy industries. The Israeli 2004 SAM used in this study (Siddig *et al*. 2011) has several distinctive features. First, the SAM differentiates between 43 industries and products, i.e., multi product industries can and do exist. Second, there are detailed data on trade and transportation margins. Third, there are 10 (representative) household groups and 36 different labour categories differentiated by profession and ethnicity. For Israeli workers there are eight skill categories, seven profession/occupation categories and one unskilled category, which are further categorized by ethnicity (Jewish and Arab & others) and gender. There are four non-Israeli labour categories; legal and illegal Palestinian cross-border and foreign workers.

The labour data are recorded as transactions in the SAM and as a matrix of real quantities; thus estimates of real wage rates and wage differentials are available. Comparing labour categories within the same skill category, female wages are significantly lower than male wages and Jewish Israeli wages are up to 20% higher than wages of Arab Israelis.

The sources of the data used to compile the SAM include the Israeli Central Bureau of Statistics (ICBS), the Central Bank of Israel (BOI), and the Israeli Tax Authority (ITA). In addition, non-Israeli sources were used to fill-in gaps in domestic reports: the World Trade Organization (WTO), the Organisation for Economic Co-operation and Development (OECD), and the World Bank.

The database also includes standard elasticities of substitution/transformation for imports and exports based on literature and plausibility considerations, the production nests and the Stone-Geary (LES) demand system.

II.4. Policy Simulation and Results

II.4.1. Policy Simulation

The simulation reported here assesses the implications of a partial reintegration of the Israeli and Palestinian labour markets. Since Israel is apparently unlikely to allow free mobility of labour between the two labour markets, the simulations concentrated on evaluating an increase in the 'quota' of Palestinian workers given access to the Israeli labour market.

The core simulation assumes that the quota on Palestinian worker was increased to 114 thousand, the pre-Intifada level, from 50 thousand, and hence that the price of Palestinian labour on the Israeli market will decline, i.e., the minimum wage law is not rigorously enforced. The high unemployment rate in the West Bank and the high gap between the wages Palestinians can receive in Israel and the wages they receive in the West Bank support the assumption of the availability of Palestinian labour to fill the increased quota. The quotas of foreign workers are assumed to remain constant. Other simulations for other 'realistic' changes in the quota were run; these produced results that are consistent with those reported.

The macroeconomic closures imposed are that the foreign exchange market is cleared by the exchange rate. Savings are investment driven, the government consumes a fixed share of absorption and balances its account by a variable income tax and the CPI serves as numéraire. These choices ensure that all adjustments take place in the solution period by avoiding passing benefits or costs to the future.

For the labour market it is assumed that the Israeli labour market for skilled and unskilled labour is characterised by full employment and adjusts by variation of the wage rate, i.e., the minimum wage law is not binding. Hence the scenarios are defined by varying factor supplies for the respective non-Israeli labour groups.

II.4.2. Results

The discussion of the results begins with the implications for the Israeli economy before moving on to the implications for the West Bank's economy.

II.4.2.1. Effects on the Israeli Economy

Increased employment of Palestinians in Israel – from 50 thousand to the pre-Intifada level of 114 thousand – results in extra workers' remittances flowing from Israel to the West Bank. The exchange rate depreciates by 0.1%, to absorb this change in the current account; this, together with cost changes (see below) increases the competitiveness of exports, while increases in domestic activity increase import demand, albeit at a slower rate (Figure II.4).

Figure II.4. Macroeconomic Effects of the Pre-Intifada Simulation in Israel, % Changes

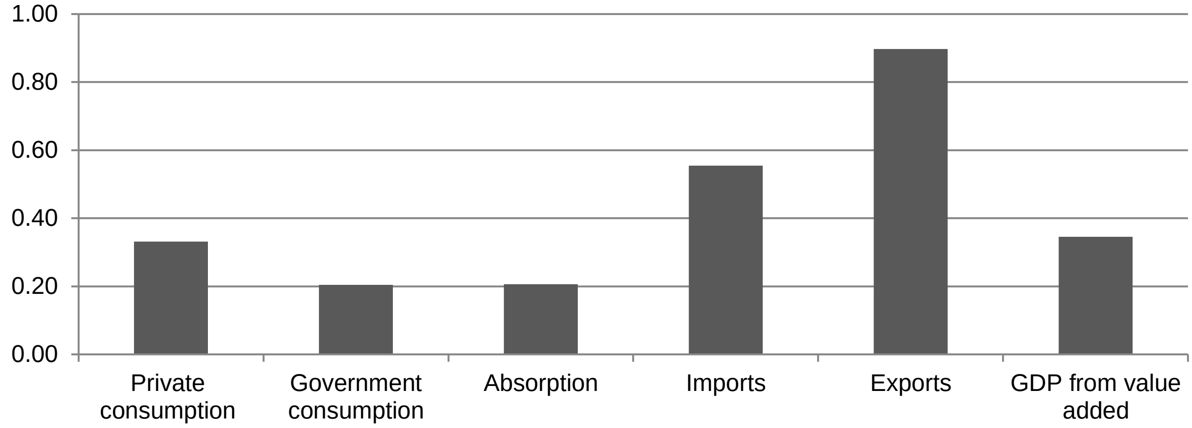
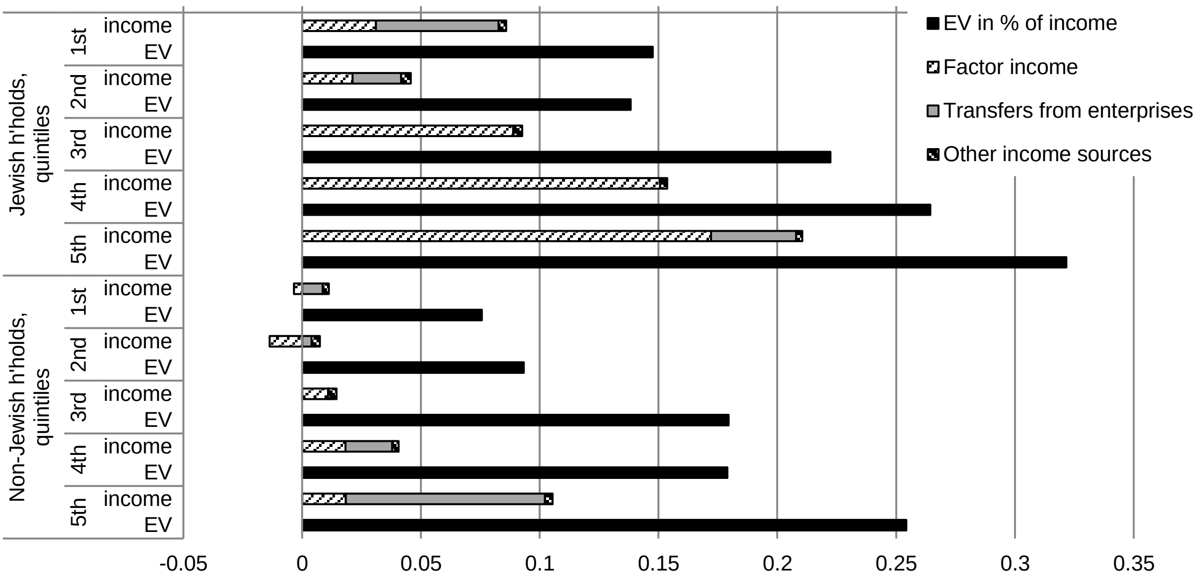


Figure II.5. Effects of the Pre-Intifada Simulation on Household Welfare, % Changes

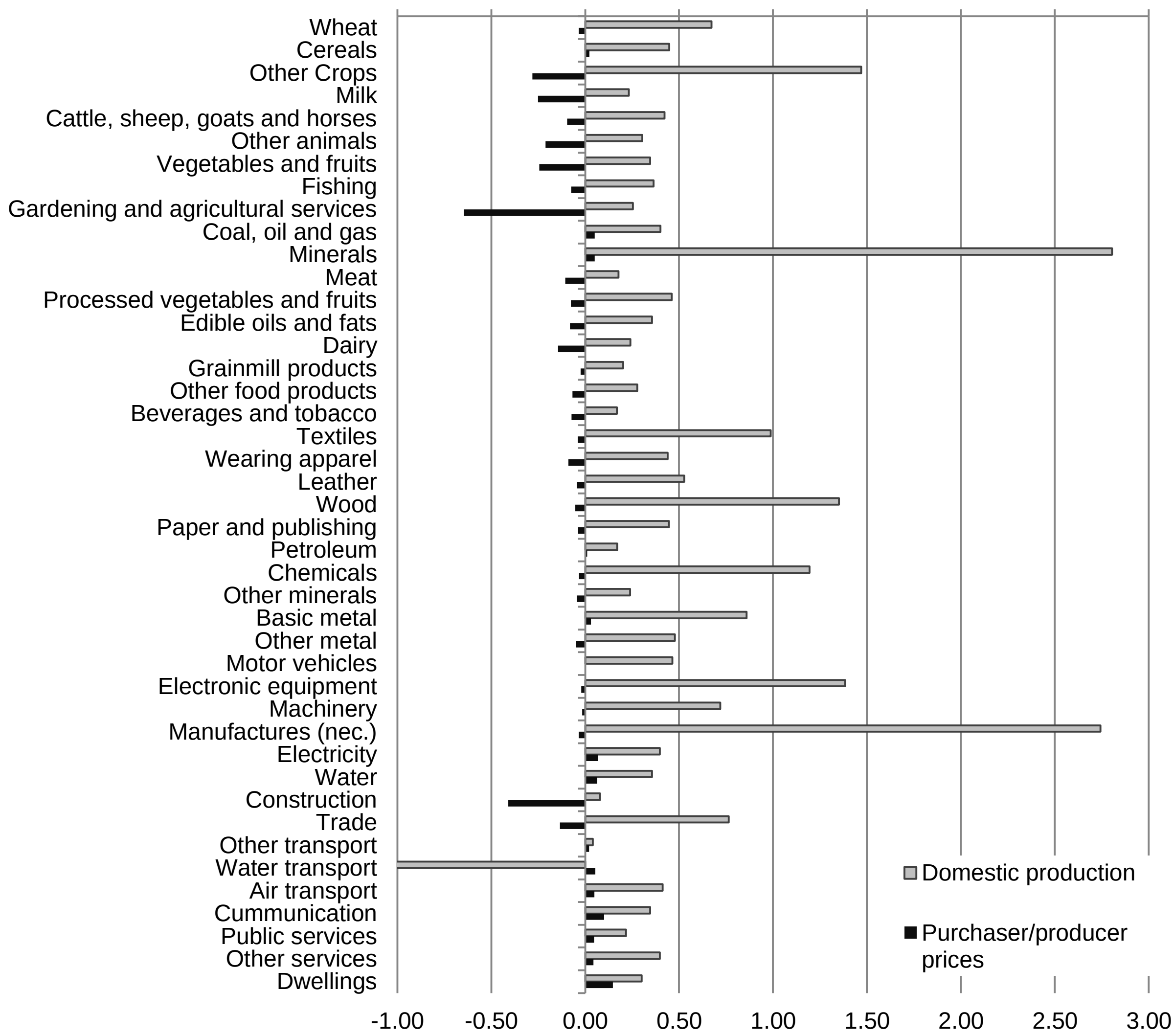


Overall there are positive benefits to the Israeli (macro) economy. Israeli GDP grows by 0.3% (Figure II.4) with private consumption, government consumption and absorption increasing. Welfare increases for all households (Figure II.5) due to increases in household incomes for all household groups, except the Arab households in the second poorest quintile, and a general reduction in purchaser prices.[7] There are distributional impacts: household groups from higher quintiles experience larger increases in income and welfare than household groups from the lower quintiles. These derive from two sources: first the changes in factor incomes, which are relatively larger for the richer households, and second changes in the household specific costs of living,[8] which decline for the two poorest quintiles but increase for the three richer quintiles. Purchaser prices decrease for most agricultural and manufacturing products but increase for most service products (Figure II.6); price declines are concentrated in staple products. The changes in cost of living confirm that the

[7] The percentage changes in purchaser prices are the same as those in the producer prices reported in Figure II.6; this is because there are no changes in tax rates or margins.
[8] As measured by the household specific consumer price indices.

changes in purchaser prices are consistent with increasing the welfare of poorer households and that the benefits to the richer households derive from increases in their incomes from factors (see below).

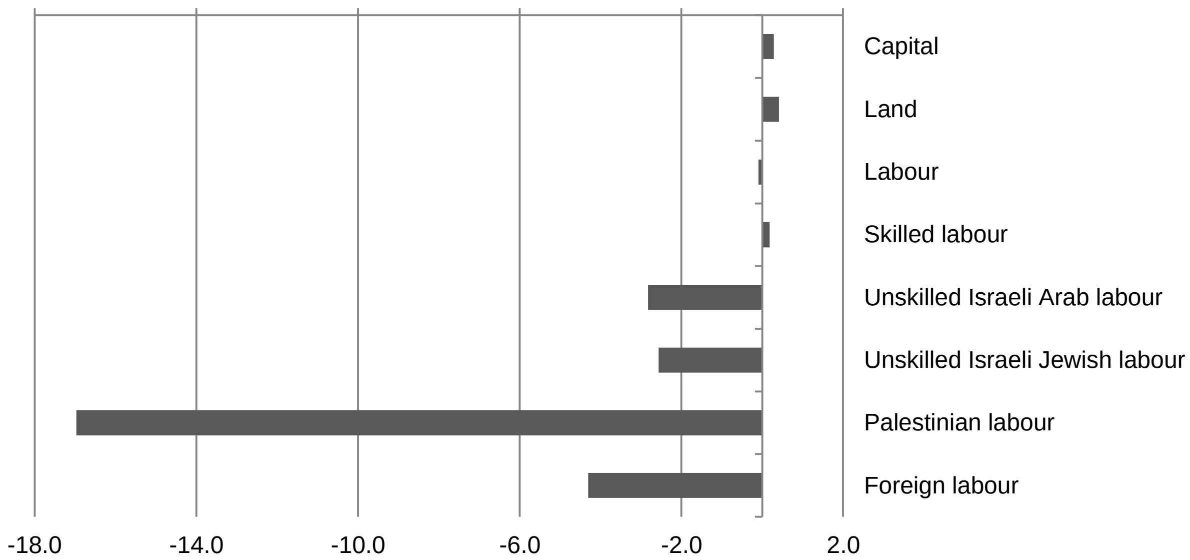
Figure II.6. Effects of the Pre-Intifada Simulation on Purchaser/Producer Prices and Domestic Output, % Changes



The increase in Palestinian labour changes the relative availability of factors and thus directly affects returns to factors. Wage rates for capital and land, which become relatively scarce, increase relative to the average wage rate for labour (Figure II.7). The effect is stronger for land because of the relative intensity of unskilled labour in agriculture (Table II.2). The increase in quantity of unskilled (Palestinian) labour causes wages for skilled labour to increase while wages of unskilled labour groups decrease. The wage rates for Palestinians decrease most (16.7%) followed by wages of other foreign workers, which are direct substitutes. The effect on Palestinian wages is strong, but needs to be considered against the background of Palestinian labour supply increasing by more than 100%, which implies the (long run) own price elasticity of demand is high (about 7), and the increase in factor income is over 275%.

Factor incomes decline for nine, out of 36, labour types. All three foreign labour types experience declines in income of 3.8 to 8.5%, unskilled Jewish and Arab & Other labour types experience income reductions of about 2.5% while female Jewish and Arab & Other skilled agricultural workers experience marginal reductions in income (less than 0.05%). All other domestic labour types experience income increases of 0.16 to 0.36%; while there is evidence that factor income increases with skills it is notable that the largest increases are experienced by skilled industrial workers. Land and capital incomes increase by 0.54% and 0.27% respectively. Thus the changes in factor incomes have the opposite impact on real income distribution to the cost of living and are dominant.

Figure II.7. Effects of the Pre-Intifada Simulation on the Wage Rates of Different Factor Groups, % Changes



Although outputs expand for all but one industry, three groups of industries can be distinguished. First, industries in which the share of unskilled labour in total labour use is high, experience reductions in input costs and prices decrease (Figure II.6). Agricultural industries such as wheat, other crops (except cereals), milk, and vegetables-fruit production as well as construction are main employers of unskilled labour (Table II.2). These industries increase production but domestic and export demand for these products is muted because demand for agricultural products, and construction, is assumed to be inelastic with respect to prices and income. The exceptions are other crops and, to a lesser extent, wheat where export expansion is important. For all agricultural and food industries and construction the costs of aggregate intermediates and value added per unit of output fall.

Second, the industrial industries, for which electronic equipment and manufactures (not elsewhere classified, nec.) are representative. Here the share of unskilled labour is around 10% or less, although there are appreciable differences across industries. Typically intermediate input costs decline or increase marginally, while factor costs increase slightly. However these industries realise relatively large production increases in response to increasing consumption and, especially, export demand.

Household income is not only composed of income from factors, but also contains transfers from government, enterprises, other households, and from the rest of the world. Most important for all household groups is factor income with a share between 50-83% in total household income. In lower, poorer, quintiles the second important source for income are transfers from the government, income from enterprises ranks third; in higher income quintiles it is the other way around. Factor income, government transfers and income from enterprises account together for more than 80% of income in all household groups, inter-household transfers and income from abroad play a minor role.

Table II.2. Share of Unskilled Labour in Total Labour Input (%), Selected Industries

Industries	Israeli unskilled	Palestinian	Foreign	Total unskilled
Wheat	10.3	3.4	24.0	37.7
Other crops	9.9	3.8	27.1	40.7
Milk	10.0	2.8	19.5	32.3
Vegetables and fruits	9.9	3.8	27.1	40.7
Construction	4.4	9.2	26.7	40.3
Electronic equipment	7.1	2.7	0.6	10.3
Manufactures (nec.)	6.9	1.9	0.4	9.2
Communication	4.1	0.6	0	4.7
Public services	4.9	0.6	3.7	9.2

For the service industries, typified by the communication and the public services industries in Table II.2, there is limited employment of unskilled and Palestinian labour except for Trade. Intermediate input costs marginally increase, except for Dwellings (due to the reduction in construction costs), while factor costs increase appreciably (0.04 to 0.23%) except for Trade where they fall by 0.22%. Nevertheless outputs increase due to increased incomes and hence expanded domestic demand. There is some increase in exports but, except for Other Transport, these industries only export small shares of their output.

Factor income increases for most of the household groups except for Arabs in the three poorest quintiles, caused by different ownership of factors. Compared to Jewish households, Arab households have a larger share in unskilled labour, which experiences a fall in wages. Moreover, compared to Arab households, Jewish households own more skilled labour. Transfers from the government do not change, but transfers from enterprises, households and abroad increase, partly absorbing the negative effects for poor Households.

Since inter household transfers and transfers from government to households are fixed in real terms the changes in household incomes are overwhelmingly driven by incomes for sale of factor services, either directly or indirectly through (intermediary) incorporated enterprises (Figure II.5). Consequently the primary determinant of the income distribution effects is the patterns of factor ownership with the richer households having greater endowments of skilled labour and capital. Therefore, the income gap between poor and rich households widens. This is ameliorated by the patterns of falling purchaser prices, a falling income tax rate and decreasing savings rate which increases disposable income and expenditures for all households.

II.4.2.2. Effects on the West Bank Economy

While cross-border workers in Israel experience a substantial, 16.97%, fall in wages; overall labour incomes rise from 1,374 NIS million in the base scenario to 2,524 NIS million (Table II.3). The near doubling of remittances raises the potential contribution of remittances form 13.8% to 25.5% of the West Bank's (2004) GDP. Thus, the simulated policy reduces unemployment in the West Bank and simultaneously increases the West Bank's income, even if no allowance is made for any multiplier effects through increases in domestic production and investment.

Table II.3. Palestinian Workers Remittances from Israel and West Bank GDP (2004)

	Base Scenario	Pre-Intifada Scenario
Workers remittances from Israel	1,374.0 NIS Million	2,524.4 NIS Million
West Bank GDP	Share of remittances in the West Bank GDP	
9,899.1 NIS Million	13.8%	25.5%

Source: PCBS, 2011

However large revenues from worker remittances can cause an appreciation of the real exchange rate – a paradox known as Dutch disease – that would offset the potential benefits from increased remittances. Nevertheless, a study by Astrup and Dessus (2005) found that increased export competitiveness for the Palestinian territories was insufficient to compensate for losses in income after closure of the Israeli labour market, indicating that cross-border employment is an important contributor to the living standard in the Palestinian territories.

II.4.2.3. Testing for the Sensitivity of the Results to the Level of the Substitution Elasticities σ_{42} and σ_{52}

The sensitivity of the results to the substitution elasticities, particularly those for the labour market equations, was assessed by systematically varying the elasticities. These analyses show that two elasticities have especially strong influences on the results: the substitution elasticities between Israeli and non-Israeli unskilled workers, σ_{42}, and between Palestinian and foreign workers, σ_{52} (Figure II.3).

Increasing the substitution elasticity between Israeli and non-Israeli unskilled workers, σ_{42}, increases the negative impacts on poor Israelis. Doubling the elasticity reduces the positive change in the quantity of products consumed, although the effects remain positive. On the other hand, when assuming an almost perfect substitutability between Israeli and non-Israeli unskilled workers, by setting the elasticity to 100, the change in consumption quantities by poor Israeli households are negative. The substitution elasticity between Israeli and non-Israeli unskilled workers may vary with the political situation since it will be indicative of the extent of the reluctance of employers to employ non-Israelis and, in particular, Palestinians. In a situation of strong political tensions, this reluctance is expected to be higher, i.e., lower elasticity, than in more peaceful situations.

When doubling the substitution elasticity between Palestinian and foreign workers, σ_{52}, and when assuming perfect substitutability, the effects on the labour market are stronger. The wage rate for aggregate labour decreases, but the main effect is a change in the allocation of wages between Palestinians and foreigners. Palestinians wages fall less if σ_{52} is high while foreigners experience a greater decline in wages. Differences in the effects on Israeli households are not large, while the effects on the macroeconomic level are very small, but positive as the elasticity is increased.

II.5. Conclusions and Outlook

This study examined the potential effects of a partial liberalization of labour market policy in Israel with respect to cross-border workers from the West Bank by simulating an increase in the number of Palestinians working in Israel from 50 thousand to the pre-Intifada level of more than 100 thousand.

The results indicate that opening the Israeli labour market to more Palestinian workers would increase domestic production, and potentially enhance economic growth in Israel, provided the labour market remains segmented. These results are robust across a wide range of substitution elasticities and are consistent with the results of Carter (2005). Opening the labour market would widen the income gap between poor and rich households in Israel by increasing the factor income of rich household groups more than those of some poorer household groups. However, the negative distributional effects of changes in factor incomes will be partially offset by greater reductions in the cost of living for poorer households. Overall there are welfare gains for all household groups in Israel.

The West Bank economy would benefit from sharply increased remittances from Palestinians working in Israel. Such additional inflows to the West Bank from employment abroad could negatively impact on the West Bank's economy. While previous studies have found a positive effect from the transfer of high labour income from Palestinian cross-border workers to the West Bank, the interaction effects are not well articulated. There is therefore a case for a multi-region CGE model for the West Bank and Israel that endogenises the Palestinian labour supply decisions and the consequent indirect effects upon the West Bank.

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III. Factor Mobility and Heterogeneous Labour

Dorothee Flaig, Harald Grethe and Scott McDonald

This chapter consists of the correspondent article which is submitted to *Labour Economics.*

Abstract:

Labour productivity can vary strongly between sectors, reflecting the fact that labour of a specific type may not be homogeneous. When labour moves from less to more productive sectors, an economy experiences a *de facto* increase in labour endowments. This study uses a CGE model in which labour reallocation is imperfect with a migration function governing the movement between sectors to separate the impacts of implicit increases in labour endowments from other impacts arising from labour reallocation. The specification of labour mobility is found critical: neglecting heterogeneous labour may change macroeconomic as well as sectoral simulation results in magnitude and direction.

Keywords:

CGE-Models, labour markets, imperfect mobility, productivity effects

JEL-Classification:

C68, J24, J42, J60, O49

III.1. Introduction

Empirical data on labour markets reports wide-ranging differences in applied wage rates across different sectors of production for factors that are notionally the same. These differences are smaller among subsets of sectors, e.g., among agricultural sectors, and larger between these subsets. There are two standard approaches to calibrate labour demand and supply in CGE models depending on whether data of the quantities of labour types demanded by sectors are known or not.[9] If labour quantities are unknown the standard (Harberger) assumption is that each labour type is homogeneous, and hence is paid the same irrespective of the sector that employs the labour. This can be viewed as a strong perfect market assumption wherein there is a one-to-one relationship between labour quantities and values, and the marginal productivity of a labour type is independent of the characteristics of the sector that currently employs that labour, e.g., the capital-labour ratios do not determine the marginal productivities of the labour types. If labour quantities are known it is possible to define sector specific wage rates for each labour type: a standard approach in this instance is to define the activity specific wage rates as the average wage rate of the labour type weighted by a labour type and sector specific productivity adjustment factor. Calibration of the Harberger assumption is a special case of this 'general' form: all the average wage rates are equal to one and all the sector productivity adjustment factors are equal to one. A problem arises, when labour factors are mobile across sectors and the sector productivity adjustment factors are not all equal, since this implies differences in the marginal productivity of the labour type according to the sector employing the labour. In these cases labour reallocations can lead to large productivity effects.

Arguably, there are three approaches to resolve this problem. In the first approach, it is (implicitly) asserted that all labour productivity differences are attributable to the sector employing the labour: hence reallocated labour adopts the sector specific productivity adjustment factor, and therefore the marginal productivities of each labour type are solely determined by the sector that employs the labour, e.g., the IFPRI standard model (Lofgren *et al.*, 2002) and the STAGE model (McDonald, 2007). This approach has the distinct advantage of producing a transparent market clearing condition, since each labour type is homogeneous and the demand for each labour type can be aggregated across sectors in terms of the stocks, e.g., person hours, of each labour type, but does not mitigate the productivity effects. A second approach is the application of a CET function, which implies that each labour type is differentiated across the using sectors and the quantity units are measured in 'efficiency' units that are the product of the stock of the labour type and the flow of services realised by use in a specific sector, e.g., the GTAP model (Hertel *et al.*, 2007). In this approach the reallocation of labour involves the movement of 'efficiency' units where the implicit assumption is, that the flow of services realised changes according to the properties of the CET functions, i.e., the elasticities and share parameters/weights. This approach has the advantage of mitigating the productivity effects, by endogenously adjusting the flow of services available to a sector from a given stock of labour, but makes the labour market clearing condition opaque, because the labour quantities are no longer recorded in 'natural' (stock) units and hence cannot be an unweighted aggregate across sectors. Moreover, since each labour type is now defined to be heterogeneous in demand, a difficulty arises in the price definition for each labour type: specifically there is only one price definition equation for

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[9] In levels (GAMS) based CGE models the process of calibration is explicit whereas in rates of change (GEMPACK) based models the process of calibration is implicit.

each type of labour and therefore it is, implicitly, assumed that the productivity of labour can change without any change in the cost of producing that labour. A third approach to account for heterogeneity within labour types is to increase the number of labour types, so that each is homogeneous. This approach seemingly solves the problems of productivity effects, makes the market clearing conditions transparent and ensures unique price definitions for each labour type. But the empirical evidence indicates that, at all realistic levels of disaggregation, each labour type becomes sector specific and hence, using standard functions, there is no possibility for reallocating labour between sectors, and therefore the model becomes worthless for practical purposes. None of these approaches is ideal.

This study develops a fourth approach, that mitigates the productivity effects, recognises the importance of sector specific characteristics, e.g., capital-labour ratios, maintains transparent market clearing conditions and (partially) solves the issue of under specified price definitions. It builds on the third approach. Labour types are disaggregated, but the possibility of labour reallocation/mobility is retained by specifying (labour) migration functions that govern the reallocation of labour across sectors. These functions are all specified in terms of labour stocks ('natural' units), which requires that the issues raised differences in the flows of labour services from different labour types in different sectors are explicitly modelled. There are two polar options: the productivity of moving labour is determined by the destination sector, which assumes that all differences in the productivity of each type of labour across sectors are attributable solely to sector specific attributes, or that the productivity of the moving labour is labour type specific, which assumes that all differences in the productivity of each type of labour across sectors are attributable solely to labour type specific attributes. Clearly there are an infinite number of alternatives between these two polar options.

Naturally, the discussion on productivity becomes relevant, when satellite accounts are used which determine physical labour units and make different wage rates between sectors visible. Given this information, when labour moves from less to more productive sectors and productivity is sector specific, an economy experiences a *de facto* increase in labour endowments. Separating the impacts of implicit increases in labour endowments from other impacts arising from labour reallocation is therefore important for the interpretation of results. With migration functions it is practical to track movements in the stock of labour types between sectors and changes in the flows of services from different labour types. Thus, for instance, the *de facto* endowment (flow of services) from different labour types can be held constant. In order to illustrate the potential of the migration function approach this study compares effects of the common sector specific productivity setup, which *de facto* increases/decreases factor endowment and homogeneous labour, and a factor specific setup, which implies constant factor endowment and heterogeneous labour.

III.2. Factor Mobility in CGEs and Productivity Effects from Labour Reallocation

Factor Mobility in CGEs

In applied CGE modelling, labour markets are usually differentiated into different groups, where the differentiation should be based on whether wages move in parallel or not (Boeters and Savard, 2011). Imperfect substitutability is thus assumed between different levels of skills, age or gender, but usually not between different sectors. Factors are typically either modelled as perfectly mobile across sectors or sector specific, thus immobile. Perfect mobility or transformability should result in a homogeneous market and equalised wages. In the real world, however, there are huge variations between wage rates of different skill classes and among sectors, e.g., see Table III.1 for Israel. These differences are typically accounted for in CGE-models with sector specific productivity/efficiency factors. When labour moves from less to more productive sectors, it typically adopts the productivity of labour in the destination sector and an economy experiences a *de facto* increase in labour endowment. This is a strong assumption, but it is an open question as to the determinants of the productivity of workers that relocate between sectors. The empirical literature on costs of factor reallocation highlights the existence of severe costs of reallocation, mainly caused by non-transferability of skills and losses in skills, which hinders mobility between sectors. For example Figura and Wascher (2010) find in a study on the US labour market a wage loss for displaced workers who switch industries of 20.8%, while those remaining in their former industries experience a wage loss of 5%. This is supported by Fallick (1996), who finds in a review of the empirical literature workers experiencing 16-20% higher earning losses upon reemployment in other sectors compared to reemployment in the old sector.

Thus, there are several reasons to regard the mobility of labour between sectors as imperfect. In CGE modelling, imperfect factor mobility is typically included with a Constant Elasticity of Transformation (CET) function. In the GTAP-model family imperfect mobility of land between agricultural sectors modelled with a CET function is a standard feature and the code allows extending this feature to all factors. Several studies address the improvement of the land supply framework in the GTAP model and estimation of the CET parameter. For example, Golub *et al*., (2006) evaluate land use change in response to climate change with different versions of land mobility and find the most restrictive version returning the most realistic outcomes. Ahmed *et al*., (2008) empirically estimate CET elasticities for different land uses with data for the USA. A recent study on the imperfect land market of Li *et al*. (2012) focusses on the estimation of CET parameters in a more flexible nesting structure. In a study for Israel and Italy, Palatnik *et al*., (2011) estimate CET elasticities based on simulations with a regional scale PMP land-use model and apply these estimates to a CGE model in which land supply is modelled with nested CET functions.

Regarding other factors of production than land, imperfect mobility is introduced in the capital market as standard in GTAP-AGR based on a CET function. In none of the models imperfect mobility is standard in the labour market. Nevertheless, there are some studies including imperfect mobility in the labour market. Ivanchovichina and Martin (2004) as well as Zhai and Wang (2002) study possible effects of China’s accession to the WTO taking into account barriers to labour mobility between rural and urban regions with a CET function. Both studies conclude that labour market reforms, mainly lifting the barrier for rural-urban migration, would significantly improve efficiency and equality. Intersectoral labour migration – between agricultural and non-agricultural sectors – is considered in a study of Valenzuela *et al*., (2008), which evaluates the sensitivity of results of global trade liberalisation to different assumptions on factor mobility, closures and trade elasticities with the GTAP model. The increase in agricultural value added is found twice as high in the specification with perfect labour mobility compared to immobile labour, which highlights the importance of the mobility assumption.

The CET function approach reallocates labour in terms of the movement of ‘efficiency’ units, where the implicit assumption is that the flow of services realised changes according to the properties of the CET functions, i.e., the elasticities and share parameters/weights. While this approach has advantages, it render the labour market clearing condition opaque, because the labour quantities are no longer recorded in 'natural' (stock) units and the price definitions for each labour type are under defined, because there is a single equation for each type of labour. Ideally, labour should be defined in 'natural'/physical units, in order to be able to track the actual quantity of workers who move between sectors and clarify the market clearing condition, while dealing explicitly with the implications for differences labour productivity across sectors. This is the purpose of this study. To this end, we model imperfect mobility using migration functions, where workers migrate between different sector blocks of production. Migration functions have been used to depict migration between countries or regions by McDonald and Thierfelder (2009). Migration between rural and urban regions can also be conceived of as migration between agricultural and other sectors. This study extends the migration function approach by defining migration bilaterally between different sector blocks of the economy. In the migration function of McDonald and Thierfelder (2009), the migration decision is based on the relative wage of the own region relative to the average wage level in all regions, with workers migrating to a pool and from that pool. In contrast, the origin of a migrating worker is traceable in the version of the migration function developed for this study.

Productivity Effects from Labour Reallocation

Productivity studies differentiate economic growth between input driven growth and technical progress. The change in output over the joint units of labour and capital gives Hicks-neutral technical progress, which is notionally an index of residual factors which contribute to the generation of output but which are not explicitly accounted for; these residual factors include, besides others, the effects of R&D, managerial capabilities and intersectoral transfer of resources (Felipe, 1999). Thus, Hicks-neutral technical progress contains the change in factor productivity from reallocation of resources between industries. The growth accounting method following Solow (1957) compares the change in output of an economy to the change in all its inputs and defines the residual, which cannot be explained by input growth, as productivity growth. Thus, estimates seek to distinguish between those parts of economic growth that can be attributed to movement along the production function (accumulation of inputs) and those caused by shifts in the production function (technical progress). This kind of measurement contains the problem that any errors in measurement appear as productivity changes (Domar, 1961; Felipe, 1999). In light of this issue, Solow's basic approach has been refined: First, inputs were disaggregated and thus differentiated by qualities, improving the measurement of inputs. Second, sectoral reallocation – from agriculture to industry, thus to capital intensive sectors and to higher marginal productivity – is a key factor in productivity growth and has been included in the standard accounting measure of total factor productivity (TFP) (e.g., Massell, 1961; Pack, 1993; Poirson, 2001).

Poirson (2001) estimates the impact of labour reallocation on economic growth rates and asks the question to what extend these reallocation effects contribute to faster or slower growth rates, using panel data for 65 countries between the years 1960 to 1990. Her findings confirm the importance of labour reallocation effects in determining economic growth rates: countries which allocate labour relatively more in sectors with a higher productivity over time grow faster. In addition, Poirson shows that missing reallocation, from agriculture to industry and services, accounts fully for the growth gap of African countries relative to other countries.

III.3. Modelling Framework

III.3.1. Main Features of the Model and Data

The model used in this study is an augmented version of the single country Computable General Equilibrium (CGE) model STAGE, which is developed by McDonald and Thierfelder (2009)[10] and derives from the ERS model of Robinson *et al*., (1990) from the early 90s. STAGE is a Social Accounting Matrix (SAM) based model that has a mix of non-linear and linear relationships that govern the behaviour of the model's agents. Utility maximisation of households is based on preferences which are represented by Stone-Geary utility functions. They consume composite aggregates of domestic and imported commodities that exhibit constant elasticity of substitution (CES), following Armington (1969), where the relative price determines the optimal mix of domestic and imported good consumption. Israel is a classic example of a small country in the world market; therefore, world market prices for imports and exports are fixed in the model.

Domestic production is modelled as a two stage production process with either constant elasticity of substitution (CES) or Leontief technologies applied. At the first stage, intermediate input and value added generate the output of each activity based on CES technology. At the second stage, the use of intermediate inputs is in fixed proportions using Leontief technology, while the CES technology is used to form value added by primary production factors where the optimal ratio of factors is determined by relative prices.

Commodity demand consists of domestic demand and export demand. The distribution of domestically produced commodities among domestic demand and exports is governed by relative prices on these markets, using constant elasticity of transformation (CET) functions, which reflects imperfect product transformation. The model is solved in General Algebraic Modelling System (GAMS).

This study uses a variant of the STAGE model that has been calibrated using an Israeli SAM of the year 2004 (Siddig *et al*., 2011). This Israeli SAM has several distinctive features. First, the SAM differentiates between 43 activities and commodities, i.e., multi product activities can and do exist. Second, there are detailed data on trade and transportation margins. Third, there are 10 (representative) household groups and 36 different labour categories, differentiated by profession and ethnicity. For Israeli workers there are eight skill categories, seven profession/occupation categories and one unskilled category, which are further categorized by ethnicity (Jewish and Arab & others) and gender. There are four non-Israeli labour categories: legal and illegal Palestinian cross-border and foreign workers. For all labour types there are data on the quantities of labour inputs, hence differences in wage rates in the model are 'real'.

The sources of the data used to compile the SAM include the Israeli Central Bureau of Statistics (ICBS), the Central Bank of Israel (BOI), and the Israeli Tax Authority (ITA). In addition, non-Israeli sources were used to fill-in gaps in domestic reports: the World Trade Organization (WTO), the Organisation for Economic Co-operation and Development (OECD), and the World Bank.

[10] Refer to McDonald and Thierfelder (2009) for a detailed description of the model.

Figure III.1: Value Added Nesting

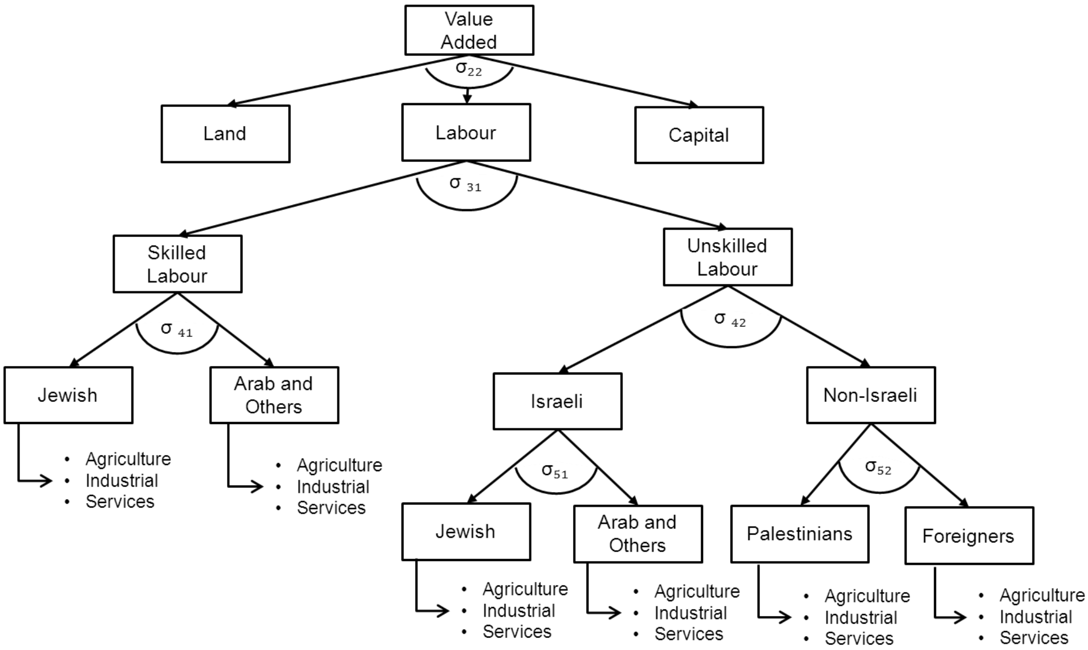


Table III.1. Labour groups

	Wages in sector blocks (NIS/month)		
Labour type	Agriculture	Industrial	Services
Skilled Jewish Israeli	6 188	17 246	14 473
Skilled Arab and Other Israeli	5 766	11 871	11 978
Unskilled Jewish Israeli	4 045	7 548	6 058
Unskilled Arab and Other Israeli	3 948	6 612	5 915
Palestinians	1 560	2 943	2 811
Foreigners from ROW	3 214	5 906	4 948

The modelling of production is changed to include a five-level production process. Each level involves CES or Leontief aggregations of primary or aggregated inputs to produce aggregates. In the first level of the production nesting, aggregate intermediate input and aggregate value added are combined to form domestic output as CES aggregate. Aggregate intermediate input is a Leontief aggregation of intermediate inputs, while aggregate value added, depicted in Figure III.1, is a combination of primary inputs using CES technologies. The CES technology allows for the assumption of imperfect substitution in factor demand between specific factor types, with the substitution elasticity σ[11] determining the substitution possibilities among them. All substitution, and transformation, elasticities are recorded as satellite accounts to the SAM.

The definitions for labour types have been redefined for this study (Table III.1). Labour types, differentiated by skill categories and ethnicity, are allocated to three segmented sector blocks:

[11] σ is set as follows: derived from literature (Hertel, 1997) $\sigma_{22}=0.8$, and in the lower nests: $\sigma=1.5$.

agricultural, industrial and service sectors. Finally, each labour type owns a labour group for each of the sector blocks.

III.3.2. Factor Productivity and Mobility

III.3.2.1. Factor Specific Productivity

The wage rates for workers of a specific labour type vary strongly across the different sector blocks (see Table III.1). When assuming that wages reflect the marginal product, the wage differences reflect differences in factor productivity. This productivity varies between and within labour types.

The model explicitly distinguishes between the stock ($f_{f,a}$) of a labour type (*f*) used by a sector (*a*) and the flow of services ($a_{f,a}^{FD}$) realised from a unit of that labour in a sector. This means, that wage rates are defined per productivity unit and are equal. This ensures that both, the stock and flow of labour services, are tracked.

The output of a sector depends on the quantities of inputs used and on their productivity. The CES production function therefore includes the productivity unit; if one worker is twice as productive as another worker, the output she produces is double as much:

$$q_a^V = \alpha_a^V * \left[\sum_f \delta_{f,a} * (a_{f,a}^{FD} * f_{f,a})^{-\rho_a}\right]^{\frac{-1}{\rho_a}} \tag{1}$$

where: q_a^V = quantity of Value Added; α_a^V = adjustment parameter;
$\boldsymbol{\delta}_{f,a}$ = share parameter; and ρ_a = elasticity parameter;

and the first order condition for profit maximisation is:

$$w_{f,a} * \left(1 + t_{f,a}^F\right) = p_a^V * q_a^V * \left[\sum_f \delta_{f,a} * \left(a_{f,a}^{FD} * f_{f,a}\right)^{-\rho_a}\right]^{-1} * \delta_{f,a} * \left(a_{f,a}^{FD} * f_{f,a}\right)^{-\rho_a - 1} \tag{2}$$

where: p_a^V= price of Value Added; $w_{f,a}$ = wage rate; and $t_{f,a}^F$ = factor use tax.

When allowing for migration between sectors, workers are assumed to gain the new sector's productivity. To allow for scenarios in which workers maintain their old productivity level the productivity factor is made factor specific. A range of intermediate alternatives can also be specified, where the factor has some proportion of sector and factor specific productivity level.

Productivity is factor (and sector block) specific, when a worker who migrates to a new sector maintains the productivity of his old sector. The average productivity (a_f) of his new sector adjusts accordingly. The total amount of productivity units a sector uses is determined by its original amount of productivity units and the amount of productivity units migrating into it. The migrating productivity unit is the actual worker who migrates from *f* to *fp* ($m_{f,fp}$)[12] times the average efficiency

[12] Where *fp* is the alias of *f* and stands here for the amount of workers migrating from one sector block specific labour type (*f*) to another (*fp*).

factor of the old labour type (a_f), which is the average productivity of a labour type inside a sector block. Thus when there are three sector blocks the productivity in block 1 after any reallocations is:

$$a_{f1} * f_{f1} = \bar{a}_{f1} * m_{f1,f1} + \bar{a}_{f2} * m_{f2,f1} + \bar{a}_{f3} * m_{f3,f1} \,. \quad (3)$$

The sector specific efficiency factor, $a^{FD}_{f,a}$, is determined by its base value, $\bar{a}^{FD}_{f,a}$, and the productivity adjustment:

$$a^{FD}_{f,a} = \bar{a}^{FD}_{f,a} * (\textstyle\sum_{fp} \bar{a}_{fp} * m_{fp,f} * aadj_{fp})/(\bar{a}_f * f_f) \quad (4)$$

where $aadj_{fp}$ represents an adjustment parameter which allows for variation in the skill transfer. If the adjustment parameter, $aadj_{fp}$, is set to a value less than 1, the worker cannot maintain her former level of income. When it equals 1, the worker maintains her old productivity; if it is greater than 1, productivity increases.

With this setting, there are four possibilities for productivity, or skill, transfer of inter-sector labour reallocation:

- Reallocated labour adopts the new sector's productivity.
- Reallocated labour retains the old sector's productivity. Thus, the average productivity of each labour type in each sector block will change.
- Reallocated labour retains the old sector's productivity adjusted for a predetermined productivity change ($aadj_{fp}$ not equal to 1).
- Reallocated labour adopts a productivity somewhere between that of the old and new sectors. Again the average productivity of each labour type in each sector block will change. For this purpose productivity is set partly sector and partly factor specific in model calibration.

III.3.2.2. Imperfect Mobility

This model includes imperfect inter-sectoral labour reallocation by developing the migration function in McDonald and Thierfelder (2009), which allows for bilateral movement between segmented blocks specific labour types, *f*, e.g., 'Agricultural skilled Arab'. The segmented blocks are defined as groups of sectors, e.g., 'Agricultural sectors' (Table III.1), within which labour is perfectly mobile. Migration is possible between the sector blocks but only within a specific labour type, e.g., 'Skilled Arab'.

Migration depends on the change in the relative wage, the wage a worker could earn in her old sector compared to the wage she could earn in another sector she could migrate to. Thus, the amount of workers who migrate, $m_{f,fp}$, from one sector block to another is determined by the change in the relative wage and the labour supply in the base situation, $\bar{f}_f$. The responsiveness of migration to wage changes is determined by the migration elasticity, η_f: If the elasticity is high, labour is mobile between the sector blocks, if it is zero, there is no migration.

$$m_{f,fp} = \bar{f}_f * \left[\frac{w^r_{f,fp}}{\bar{w}^r_{f,fp}}\right]^{\eta_f} - \bar{f}_f \qquad \forall\, f \neq fp. \tag{5}$$

The number of workers who are migrating and the workers who remain in their old sector of work must equal the base labour supply in this labour type, so that labour markets are cleared in stock terms, i.e.,

$$\bar{f}_f = \sum_{fp} m_{f,fp} \tag{6}$$

where fp contains all sector blocks a specific labour type is employed in.

The labour supplies of all labour types that cannot migrate are fixed in the closures. If migration is allowed, labour supply is the sum of all workers of a labour type which migrate to a sector block

$$f_f = \sum_{fp} m_{fp,f}.$$

III.4. Simulations and Results

III.4.1. Simulations

This model allows the user to disentangle and quantify the size of the productivity effects of labour reallocation from other effects arising from an economic shock. The model specification allows addressing the question whether and to what extent the changes in labour specific productivity among sectors matters for growth and welfare results. For illustrative purposes two scenarios are implemented:

1. *Mig2man*: An isolated 20% increase in world market prices of industrial goods, which causes labour migration from sectors with low productivity to sectors with higher productivity; and
2. *Mig2agr*: An isolated 20% increase in world market prices of agricultural goods, which causes labour migration from sectors with high productivity to sectors with lower productivity.

Each of the simulations is implemented for each of the polar opposite productivity options controlling the productivity of reallocated labour:

(a) *~_sec*: Reallocated labour adopts the new sector's productivity.

(b) *~_fac*: Reallocated labour retains the old sector's productivity.

Thus, there are four different scenarios that differ by the overall amount of productivity units available in the economy and the effects on the labour productivity within sectors, as shown in Table III.2. The effects from changes in *de facto* labour endowment compared to pure labour reallocation are analysed by comparing simulations 1a (*mig2man_sec*) with 1b (*mig2man_fac*) and 2a (*mig2agr_sec*) with 2b (*mig2agr_fac*).

The macroeconomic closures are set as follows: investment is savings driven; the exchange rate is flexible to clear the balance of payments; the government consumes a fixed value and balances its income with a variable income tax; and the CPI is the numéraire. In the factor market, all factors are fully employed and mobile between sectors. Labour is assumed perfectly mobile within sector blocks and imperfectly mobile among sector blocks inside labour types. The migration elasticity is offset as 1.5.

Table III.2. Simulation Setup

	(a) Sector specific productivity	(b) Factor specific productivity
1. Migration from low to high productivity (to manufacturing)	*(1a)* Increase in factor endowment/ productivity units Average productivity in each sector not directly affected by migration	*(1b)* Constant factor endowment/ productivity units Decreasing average productivity in manufacturing sectors
2. Migration from high to low productivity (to agriculture)	*(2a)* Decrease in factor endowment/ productivity units Average productivity in each sector not directly affected by migration	*(2b)* Constant factor endowment/ productivity units Increasing average productivity in agricultural sectors

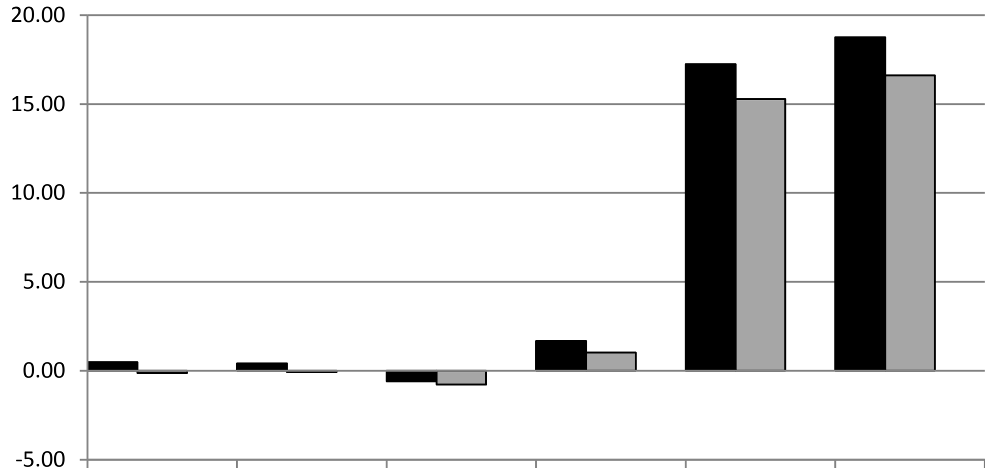
III.4.2. Results and Analysis

Results are presented as percentage deviation from the base situation before the world market price changes.

III.4.2.1. Increasing Total Factor Productivity (Scenarios *mig2man_sec* and *mig2man_fac*)

The first scenario simulates an increase of the world market prices for manufacturing goods by 20%. The increased export price increases manufacturing exports and thus increases domestic production of manufacturing goods (Appendix). At the same time imports become more expensive and manufacturing imports are reduced, which increases demand for domestic produced goods and stimulates, too, domestic industrial production. The value of exports increases strongly, the value of imports is reduced and the domestic currency appreciates strongly, 14.7%, to maintain the current account balance. This appreciation in turn decreases import and export prices, resulting in an effective import/export price increase of industrial goods of around only 2.3% and decrease of prices of agricultural and services products by -14.7%. Manufacturing is boosted in this simulation, shifting resources from agriculture and services into the manufacturing sector block (Table III.3). Wages are higher in manufacturing compared to agriculture and services and factor income increases accordingly in *mig2man_sec* (Figure III.2); household income and GDP increase.

Figure III.2. Scenario ***mig2man***: Macroeconomic Effects, % Changes, and Difference between *mig2man_sec* and *mig2man_fac* (Variables Depicted in Value Terms).



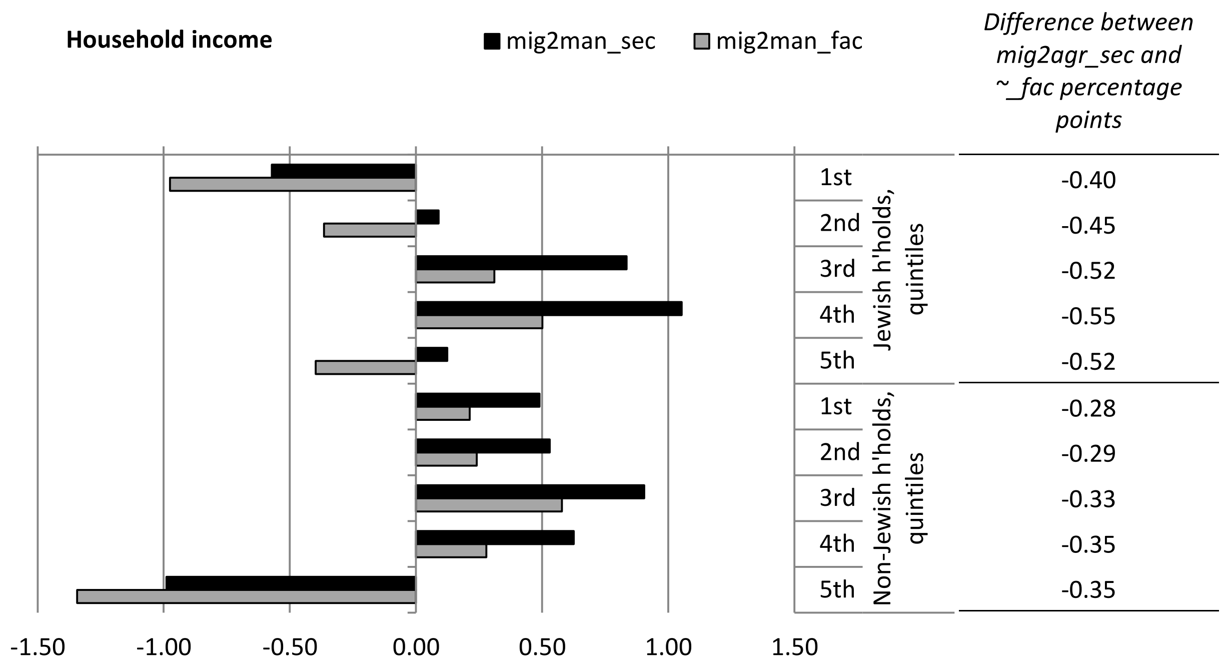
	GDP from expenditure	Household income	Government income	Labour factor income	Import demand	Export supply
■ mig2man_sec	0.49	0.42	-0.59	1.68	17.25	18.75
□ mig2man_fac	-0.12	-0.07	-0.78	1.02	15.27	16.61
Diff. in percentage points	-0.62	-0.49	-0.18	-0.66	-1.98	-2.14

Table III.3. Scenario ***mig2man***: Effects on Labour Supply, Wages and Productivity Adjustment, % Changes

			Labour demand (productivity units)		Change of productivity (a_f) in *mig2man_fac*	Labour supply (workers) *mig2man*		Wage (workers) *mig2man*	
			_sec	*_fac*		*_sec*	*_fac*	*_sec*	*_fac*
Skilled workers	Jewish Israeli	Agriculture	-8.22	-7.75	0.00	-8.14	-7.68	-0.94	-1.45
		Manufacturing	22.80	18.41	-3.04	20.26	19.87	3.21	2.50
		Services	-5.43	-5.31	-0.03	-4.41	-4.33	0.24	-0.40
	Non-Jewish Israeli	Agriculture	-9.17	-9.00	0.00	-9.09	-8.93	-0.56	-0.88
		Manufacturing	16.90	17.51	-0.41	15.32	16.44	3.76	3.49
		Services	-4.72	-5.00	-0.06	-3.88	-4.21	1.08	0.61
Unskilled workers	Jewish Israeli	Agriculture	-7.81	-7.27	0.00	-7.75	-7.22	-1.26	-1.81
		Manufacturing	23.75	18.23	-3.71	21.15	20.49	2.59	1.81
		Services	-4.32	-4.21	-0.03	-3.87	-3.76	-0.05	-0.73
	Non-Jewish Israeli	Agriculture	-8.60	-8.23	0.00	-8.67	-8.29	-1.02	-1.48
		Manufacturing	18.77	16.71	-2.12	16.82	17.40	2.84	2.28
		Services	-3.29	-3.46	-0.07	-2.85	-3.00	0.79	0.16
	Foreign from Palestine	Agriculture	-9.41	-8.91	0.00	-9.41	-8.91	-0.16	-0.72
		Manufacturing	15.58	14.45	-1.64	15.58	16.36	3.93	3.25
		Services	-2.57	-2.90	-0.14	-2.58	-2.81	1.96	1.16
	Foreign from ROW	Agriculture	-5.05	-4.47	0.00	-5.05	-4.47	-3.24	-3.82
		Manufacturing	26.41	11.70	-8.92	26.41	22.64	-2.09	-2.84
		Services	0.49	0.29	-0.18	0.59	0.53	-1.15	-1.95

When introducing factor specific productivity in *mig2man_fac*, it is assumed that workers keep their level of productivity constant, regardless to the industry they are working in. Each worker who migrates changes the labour productivity in the destination sector, and thus the average wage in the destination factor type. The change of productivity, depicted in percentage change of the factors' productivity, is shown in the third column in Table III.3. The change in productivity depends on the factor type and decreases the wage of a productivity unit by up to -6.7%. The changes in the wage of workers, shown in the last two columns of Table III.3, consist of the changes in productivity unit wage and the productivity adjustment. Wages are lower and relative wage changes are smaller with this productivity adjustment, leading to less migration. There are less workers and productivity units available in manufacturing sectors (first and second column in Table III.3), to a smaller extend also in services where in-migration from agriculture takes place, and the sectors do not have the capacity to increase the production to the extend as before in *mig2man_fac*. Agricultural production benefits from the reduced outflow of workers and shrinks less than before.

Figure III.3. Scenario ***mig2man***: Effects on Household Income, % Changes



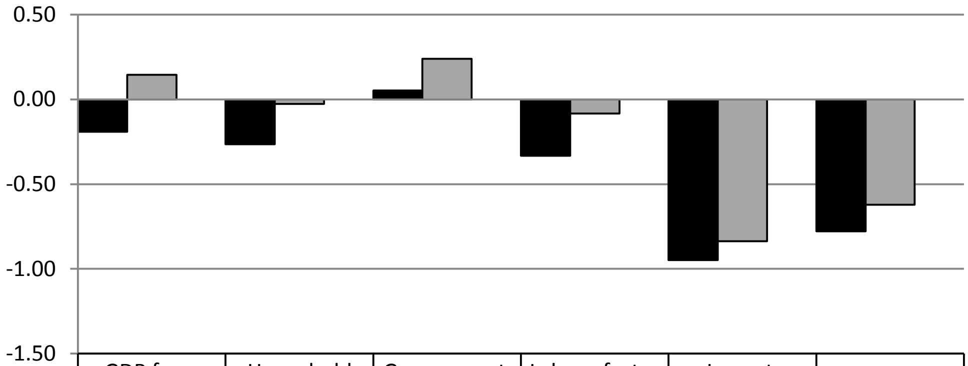
The productivity of a worker is constant in *mig2man_fac*, but the revenue per productivity unit can change. Total labour factor income increases in both scenario setups, but the increase is 39% lower with factor specific productivity (Figure III.2). The changes in household income differ appreciably: despite the increase in labour income, total household income is considerably lower and decreases (Figure III.2) in *mig2man_fac* due to decreasing income from capital (returns from capital decrease -3.7% in *mig2man_sec* and -4.3% in *~_fac*) and land (-15.0% in *mig2man_sec* and -14.6% in *~fac*[13]). When looking at the effects on households in more detail (Figure III.3), differences between the two scenarios are obvious: while in *mig2man_sec* two households experience negative income effects, there are four in *mig2man_fac*. Changes in income are 0.3-0.6 percentage points lower in

[13] Revenues from land decrease due to less agricultural production which decreases demand for land. The expanding sector block manufacturing is less capital intensive and returns from capital decrease.

mig2man_fac what mostly more than halves the effects. Income effects change direction in the Jewish 2^{nd} and 5^{th} quintile. The household groups which are affected negatively have large income shares, first in transfers from other households and the government (1^{st} and 2^{nd} Jewish), and second in income from capital (5^{th} Jewish and non-Jewish), which both decrease. Transfers are distributed in fixed shares and depend on income, which decreases for the government in both simulations and in *mig2man_fac* for rich households, which are the main sources for transfer payments.

III.4.2.2. Decreasing Total Factor Productivity (Scenarios *mig2agr_sec* and *mig2agr_fac*)

Figure III.4 Scenario ***mig2agr***: Macroeconomic Effects, % Changes and Difference between *mig2agr_sec* and *mig2agr_fac* (Variables Depicted in Value Terms).



	GDP from expenditure	Household income	Government income	Labour factor income	Import demand	Export supply
■ mig2agr_sec	-0.19	-0.26	0.05	-0.33	-0.95	-0.78
□ mig2agr_fac	0.14	-0.03	0.24	-0.08	-0.84	-0.62
Diff. in percentage points	0.34	0.24	0.19	0.25	0.11	0.16

The second scenario simulates an increase of the world market prices for agricultural goods, which increases agricultural exports – between 42% for milk and 85% for crops (non-cereals) – and stimulates domestic agricultural production (Appendix). At the same time agricultural imports become more expensive, which decreases imports – between 10% for cereals and 36% for fruits and vegetables –, increases demand for domestically produced agricultural goods and further stimulates domestic agricultural production. Labour demand in agricultural sectors increases, which raises the relative wage and leads to migration into agriculture. Wages in agriculture are between 30% and up to 70% lower than in industry and services (Table III.1) and the relative wage increase in agriculture is not high enough to close this gap. As a consequence, factor incomes from labour decrease by -0.33% in *mig2agr_sec* (Figure III.4). The reduced household income, by -0.26%, reduces expenditures and GDP declines by -0.19%. The domestic currency appreciates by 0.21% to keep the current account balanced, which decreases the competitiveness of exports. While agricultural exports, which account for 2.04% of total exports, experience a boost, total exports decrease by -0.78%. Despite the appreciation, total imports decline by -0.95% because of the increased import price of agricultural goods, decreasing demand of households and decreasing intermediate demand (the decrease in imports is mainly triggered by minerals and oil, basic metal and electronic equipment that are mainly used as intermediates in the declining production of other goods).

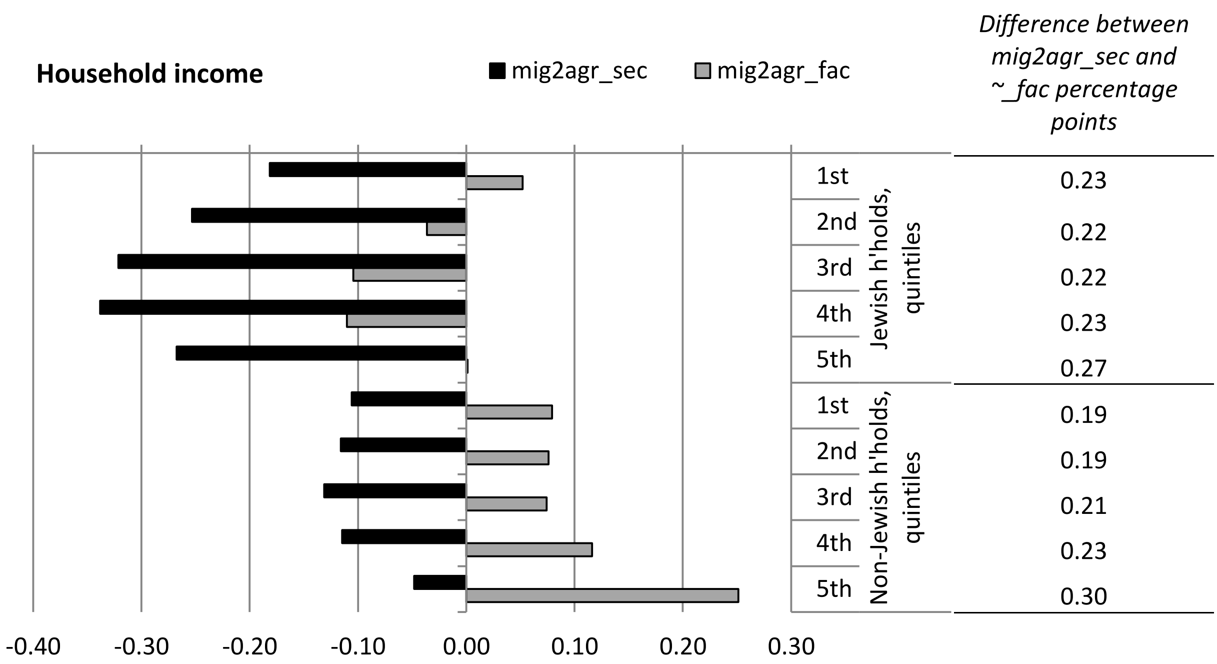
Table III.4. Scenario ***mig2agr***: Effects on Labour Supply, Wages and Productivity Adjustment, % Changes

			Labour demand (productivity units)		Change of productivity (a_f) in *mig2agr_fac*	Labour supply (workers) *mig2agr*		Wage (workers) *mig2agr*	
			_sec	*_fac*		*_sec*	*_fac*	*_sec*	*_fac*
Skilled workers	Jewish Israeli	Agriculture	19.75	51.30	25.63	19.51	20.09	0.34	0.64
		Manufacturing	-2.08	-2.61	0.00	-1.81	-2.23	-0.41	-0.23
		Services	-0.29	-0.17	0.04	-0.27	-0.19	0.05	0.37
	Non-Jewish Israeli	Agriculture	19.62	31.29	13.91	19.39	14.95	0.71	0.76
		Manufacturing	-1.92	-2.07	0.00	-1.77	-1.86	-0.09	0.00
		Services	-0.51	-0.27	0.00	-0.49	-0.24	0.28	0.47
Unskilled workers	Jewish Israeli	Agriculture	18.91	17.87	6.28	18.74	10.69	0.84	0.61
		Manufacturing	-2.44	-2.57	0.00	-2.17	-2.19	-0.15	-0.24
		Services	-0.66	-0.14	0.05	-0.67	-0.19	0.30	0.36
	Non-Jewish Israeli	Agriculture	18.62	16.95	5.54	18.85	11.11	1.41	1.03
		Manufacturing	-2.47	-2.33	0.00	-2.30	-2.08	0.26	0.13
		Services	-1.03	-0.44	0.02	-1.04	-0.46	0.64	0.62
	Foreign from Palestine	Agriculture	17.15	19.06	7.83	17.15	10.42	1.74	1.27
		Manufacturing	-2.62	-2.36	0.00	-2.62	-2.36	0.41	0.23
		Services	-1.22	-0.56	0.01	-1.20	-0.55	0.84	0.77
	Foreign from ROW	Agriculture	14.41	11.01	3.63	14.41	7.13	3.36	1.98
		Manufacturing	-3.80	-2.89	0.00	-3.80	-2.89	1.23	0.59
		Services	-2.52	-1.24	0.00	-2.51	-1.23	1.66	1.14

When assuming factor-specific productivity in *mig2agr_fac*, average productivity increases in agricultural labour types by 4%-26% (Table III.4, third column). Wages of skilled workers, i.e., skilled Jewish Israelis, are far higher in all sector blocks compared to unskilled workers. Furthermore wages differences between agriculture and manufacturing are larger for skilled labour types: a skilled manufacturing worker earns more than twice as much as a skilled agricultural worker (Table III.1). When workers keep their old productivity, in *mig2man_fac*, skilled Jewish Israeli workers are most sought after and the agricultural sector substitutes other labour types with these high productive labour types (Table III.4, labour demand and labour supply). This boost in productivity implies, that the average worker in agriculture accounts for more productivity units and thus the supply of productivity units in agriculture increases, which decreases the return to productivity units. The wages of workers, which are combinations of the number of productivity units per worker and the wage rates per productivity unit, are higher or decline less in *mig2agr_fac* for all labour types. However, total labour income is negative in *mig2agr_fac* (-0.08%), as is (total) household income (-0.03%), but compared to *mig2agr_sec* the effects are markedly less negative. A relative wage increase leads to more migration into agriculture. Agriculture has more productivity units available at lower prices compared to *mig2agr_sec*, and agricultural production therefore increases more strongly. Decreasing production costs in agriculture increases competitiveness in the world market, agricultural exports increase and agricultural imports decrease. The GDP consists of private expenditures, government expenditures, investment, and the trade balance. Since imports decrease more than exports and government income increases, due to an increase in income from the capital tax and land prices (returns to capital and land increase and, in Israel, all land is state owned) GDP increases in *mig2agr_fac* whereas in *mig2agr_sec* it falls.

Regarding the distributional effects, income decreases in *mig2agr_sec* for all households (Figure III.5). Incomes of Jewish households are more affected than non-Jewish households because their wage gap between agriculture and manufacturing, and hence migration, is greater (72% versus 59%). When workers are assumed to keep their productivity in *mig2agr_fac*, income effects are positive in all non-Jewish households and less negative in Jewish households. Jews are more heavily employed in non-agricultural-sectors, even after migration, and the manufacturing labour types experience decreasing wages. An exception is the 5th Jewish quintile that receives a large share of its income from returns to enterprises, which increase by 0.6%.

Figure III.5. Scenario ***mig2agr***: Effects on Household Income, % Changes

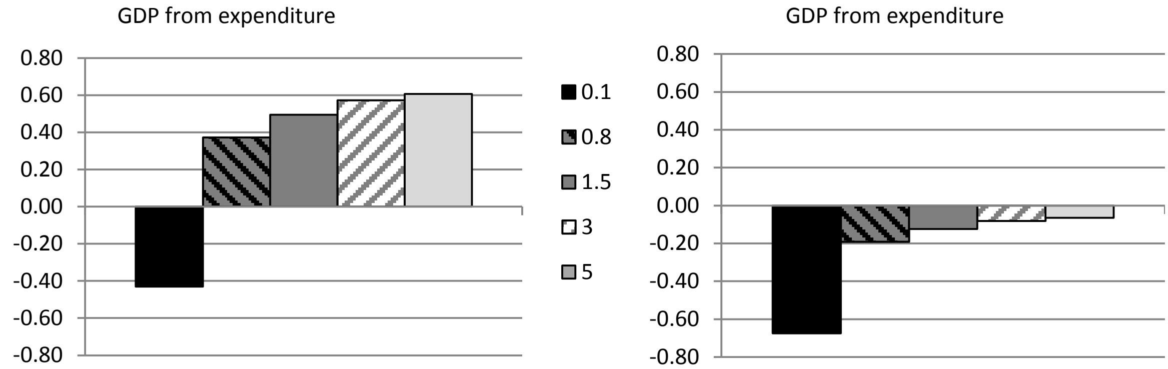


III.4.3. Sensitivity Analysis

The value chosen for the migration elasticity seems crucial for the strength of the adjustment effects in the labour market and thus the estimation of the productivity effects. A detailed analysis of the migration elasticity with values between very inelastic (0.1) and very elastic (5) shows, that unsurprisingly the effects discussed in the previous chapter are stronger with increasing migration elasticity, which results in stronger migration (Figure III.6, shown exemplary for the macro variables). The differences between the simulations with sector specific and factor specific productivity are consistently larger the higher the migration elasticity, too.

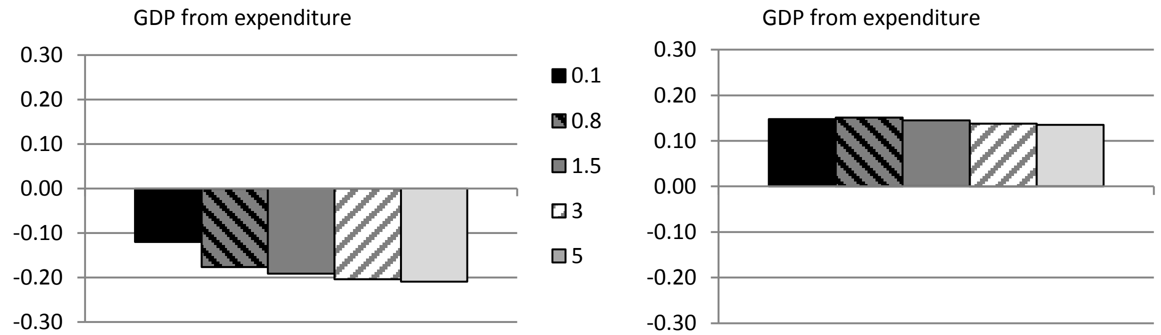
Figure III.6. Macroeconomic Results with Different Values of the Migration Elasticity

mig2man_sec *mig2man_fac*



	GDP from expenditure				
Value migration elasticity	0.1	0.8	1.5	3	5
Difference in percentage points	-0.24	-0.57	-0.62	-0.66	-0.67

mig2agr_sec *mig2agr_fac*



	difference in percentage points				
Value migration elasticity	0.1	0.8	1.5	3	5
Difference in percentage points	0.27	0.33	0.34	0.34	0.34

A second set of elasticities which affects the factor market, or more specifically affects the response to productivity changes, are the CES-elasticities in the nested production function. A systematic analysis shows the particular role of the substitution elasticities in combination with the feature of factor specific productivity, because the substitution is not only driven by the wage rate, but also influenced by the productivity effects. The reason for this is factor demand, which is not only determined by gradually changing wages, but also by strong changes in productivity. The model has difficulties to solve with high substitution elasticities when there are large productivity differences between the branches of a nest, in a test run with smaller productivity differences the model runs smoothly also with high substitution elasticities. In the Israeli model, the results are highly sensitive to two substitution elasticities, displayed in Table III.5 for changes in factor supply: σ_{31} in Figure III.1 governing the substitution between skilled and unskilled workers, and σ_{41} governing the substitution between skilled Jewish and non-Jewish Israelis. The examined scenario *mig2agr_fac* simulates a boosting agricultural sector; skilled workers are by far more productive in all sector blocks compared to unskilled workers. Furthermore, differences between agriculture and manufacturing are larger for skilled labour types: a skilled manufacturing worker is more than twice as productive as a skilled agricultural worker; the difference is less for unskilled workers. Regarding the substitution between skilled and unskilled workers, when workers keep their old productivity skilled workers are most attractive for the expanding agricultural sector. The more substitution is possible, the more skilled workers are employed in agriculture and less unskilled workers are needed, making unskilled workers finally moving out of agriculture and into services in the setup with strong substitutability. Regarding the substitutability between Jewish and Non-Jewish skilled workers, the same behaviour is observable: skilled Jewish workers are 2.8 times and skilled non-Jews 2.0 times more productive in manufacturing compared to agriculture[14]. Thus a high elasticity leads to very strong substitution effects and the less productive workers are pushed out of the market.

Table III.5. Sensitivity of Results from *mig2agr_fac* to Substitution Elasticities σ_{31} and σ_{41}

Factor supply, % changes			Different values for σ_{31} (substitution between skilled and unskilled workers)			Different values for σ_{41} (substitution between skilled Jews and skilled Arabs)		
		Elasticity value	0.1	1.5	3	0.1	1.5	3
Skilled workers	Jewish Israeli	Agriculture	12.87	20.09	28.03	18.19	20.09	25.20
		Manufacturing	-1.29	-2.23	-2.64	-2.13	-2.23	-2.44
		Services	-0.16	-0.19	-0.38	-0.15	-0.19	-0.32
	Non-Jewish Israeli	Agriculture	9.39	14.95	22.06	22.11	14.95	-7.15
		Manufacturing	-1.00	-1.86	-2.23	-2.21	-1.86	-0.62
		Services	-0.20	-0.24	-0.49	-0.50	-0.24	0.54
Unskilled workers	Jewish Israeli	Agriculture	21.92	10.69	-11.76	11.06	10.69	9.70
		Manufacturing	-2.37	-2.19	-0.62	-2.16	-2.19	-2.19
		Services	-0.82	-0.19	0.83	-0.21	-0.19	-0.13
	Non-Jewish Israeli	Agriculture	21.36	11.11	-10.62	11.32	11.11	10.38
		Manufacturing	-2.53	-2.08	-0.10	-2.11	-2.08	-2.06
		Services	-1.19	-0.46	0.88	-0.47	-0.46	-0.40
	Foreign from Palestine	Agriculture	21.88	10.42	-11.35	10.37	10.42	9.57
		Manufacturing	-2.98	-2.36	0.10	-2.55	-2.36	-2.30
		Services	-1.61	-0.55	1.17	-0.51	-0.55	-0.48
	Foreign from ROW	Agriculture	15.51	7.13	-9.29	7.17	7.13	6.49
		Manufacturing	-3.99	-2.89	4.09	-3.03	-2.89	-2.80
		Services	-2.70	-1.23	1.60	-1.23	-1.23	-1.12

III.5. Conclusions

Labour reallocation, typically from sectors with lower to sectors with higher labour productivity, is an important part in the explanation of economic growth. Empirical evidence suggests, however, that labour migrating between sectors experience wage losses and that labour types are not homogeneous across sectors. Neglecting factor reallocation costs and factor specific productivity in CGE-modelling might overestimate the size of potential adjustments in the labour market as a response to exogenous shocks and thus affect simulation results. This study estimates the size and

[14] The assumption that wage differences reflect productivity differences is highly questionable when there is wage discrimination in the labour market, as it is the case between non-Jewish and Jewish labour types in Israel.

relevance of productivity effects from factor reallocation. For this purpose, two scenarios of world market price changes are run in a model where imperfect factor mobility is introduced using migration functions. The first causes labour to move from agriculture to manufacturing and thus simulating labour migration to sectors with higher labour productivity, resulting in increasing total factor productivity. The second scenario causes migration from manufacturing to agriculture, leading to decreases in total factor productivity. Both scenarios are run two times: first, labour assumes the destination sector's productivity and thus average sectoral labour productivity changes, and second, labour keeps the productivity from its sector of origin and thus average sectoral labour productivity is held constant.

In the first scenario, which simulates a productivity increasing allocation, the GDP effect is 125% smaller when excluding the productivity effect and productivity is held constant. This means, that the GDP growth of 0.49% becomes a decline of -0.12% when the productivity effect is excluded. All agents of the economy benefit from the increase in productivity if it is modelled as sector specific: when the productivity effect falls away households and the government experience clear losses. Adjustment effects which lead to a lower total factor productivity, i.e., movement into agriculture, are simulated in the second scenario. The losses connected with this factor reallocation are quantified by comparing the first run with sector specific labour productivity to the second run, when productivity is factor specific and thus held constant for the economy as a whole. GDP is 0.34 percentage points higher, when total factor productivity does not decrease. All household groups are less negatively affected when assuming constant productivity, with the poor being positively affected.

The results show the importance of productivity effects from factor reallocation for model outcomes. This is valid in case of imperfect labour mobility and becomes more relevant with higher migration elasticities, such as modelled in this paper, as well as with perfect labour mobility, which would result in even stronger productivity effects due to the stronger reallocation of labour. The size of the productivity effect depends on the extent of labour reallocation as well as on the sectoral differences in productivity.

Both setups, fully sector specific productivity or fully factor specific productivity, are extremes. This study uses these extremes to show the relevance of the labour market specification for simulation results. For a realistic depiction of the labour market it is likely that the specification should be somewhere in between the extremes and would depend, besides others, on who migrates first, which part of the productivity is sector specific and/or the time horizon. The productivity setup should be more factor specific in the short run, and in the long run, when workers are adapting to their new tasks, productivity becomes more sector specific. Regarding the question on who migrates first, one might argue that the best workers are the first to migrate because they have the highest capacity to adapt to a new labour type (e.g., a higher skill level or sector to work). Then migration should decrease productivity in the old sector of work and affect positively productivity in the new sector. On the other hand, a firm that decreases employment first might release the least productive workers or those workers who choose to change their situation may be less suited to the job. With this assumption migration should increase productivity in the old sector of employment and negatively influence the destination factor type. Which effect dominates depends on the specific situation. When no empirical evidence exists, it is suggested that the model should be based on the assumption that migrants move with average and not marginal productivity.

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III.8. Appendix: Effects on the sectors of the economy, % changes

Scenario *mig2man*

	Production quantity			Supply of composite commodity			Purchaser price		
	~_fac	*~_sec*	difference in percentage points	*~_fac*	*~_sec*	difference in percentage points	*~_fac*	*~_sec*	difference in percentage points
Wheat	-16.37	-15.16	1.21	4.58	4.87	0.29	-11.23	-10.71	0.52
Cereals	-17.70	-16.06	1.64	4.39	4.71	0.32	-11.60	-11.11	0.48
Other crops	-20.01	-19.07	0.95	-1.53	-1.47	0.06	-1.80	-1.84	-0.03
Milk	0.21	0.15	-0.05	1.28	1.25	-0.03	-1.82	-1.95	-0.13
Bovine cattle, sheep, goats, and horses	-6.79	-6.18	0.61	1.80	1.72	-0.07	-5.22	-5.43	-0.21
Other animal farming	-4.32	-4.09	0.23	-0.06	-0.06	0.01	-0.42	-0.63	-0.21
Fruits and vegetables	-7.70	-7.36	0.34	0.38	0.31	-0.07	1.58	1.31	-0.27
Fishing	-2.41	-1.88	0.53	2.91	3.17	0.25	0.84	0.49	-0.35
Gardening, mixed and unclassified farming	-2.94	-3.32	-0.39	-1.23	-1.73	-0.49	-1.71	-1.72	-0.02
Coal, oil, and gas	4.02	4.73	0.72	0.66	0.30	-0.36	2.21	2.98	0.77
Minerals nec	81.11	78.17	-2.94	69.66	60.22	-9.43	2.26	2.92	0.67
Meat products nec	0.73	0.55	-0.17	0.12	-0.13	-0.25	0.24	0.76	0.52
Processing of fruit, vegetables and fish	4.91	5.61	0.70	1.14	0.87	-0.27	0.33	0.60	0.27
Manufacture of edible oils, margarine and oil products	5.00	5.11	0.11	2.99	2.93	-0.06	0.46	0.83	0.37
Dairy Products	1.52	1.28	-0.24	1.01	0.70	-0.30	-0.50	-0.09	0.41
Manufacture of grain-mill products	5.28	5.50	0.23	-0.08	-0.13	-0.05	-4.36	-3.95	0.41
Other food products	2.35	2.33	-0.03	0.61	0.31	-0.29	0.24	0.71	0.47
Beverages and tobacco manufacturing	0.95	1.06	0.10	0.27	0.07	-0.20	0.48	0.63	0.15
Textiles	9.80	11.14	1.34	4.01	3.82	-0.19	1.07	1.56	0.50
Wearing apparel	0.73	0.62	-0.11	-0.11	-0.74	-0.63	0.66	0.91	0.26
Leather products	2.25	3.36	1.11	-0.06	-0.58	-0.52	1.10	1.29	0.19
Wood products	35.06	30.56	-4.50	32.63	27.98	-4.66	0.68	1.37	0.69

Scenario *mig2man* (contd.)	Production quantity			Supply of composite commodity			Purchaser price		
	~_fac	*~_sec*	difference in percentage points	*~_fac*	*~_sec*	difference in percentage points	*~_fac*	*~_sec*	difference in percentage points
Paper products and publishing	0.36	-0.01	-0.36	-0.56	-0.94	-0.37	0.75	1.54	0.79
Petroleum and coal products	1.15	0.82	-0.32	0.58	0.07	-0.51	1.71	2.32	0.60
Chemical, rubber, and plastic products	22.14	22.86	0.71	8.93	8.61	-0.32	0.28	0.93	0.64
Mineral non-metallic products	3.55	2.55	-1.00	1.78	0.73	-1.05	0.33	1.06	0.73
Basic metal	19.77	18.20	-1.57	16.31	14.14	-2.16	1.72	2.38	0.66
Metal products (excl. machinery, equipm.)	8.43	6.66	-1.76	6.62	5.14	-1.48	0.20	1.18	0.98
Motor vehicles and parts	0.90	0.95	0.05	-0.54	-1.62	-1.08	1.61	2.17	0.56
Electronic equipment	33.89	27.50	-6.39	7.78	5.57	-2.22	0.36	1.41	1.04
Machinery and equipment nec	12.97	10.57	-2.40	4.01	2.67	-1.34	0.57	1.54	0.97
Manufactures nec	78.53	67.60	-10.93	43.24	36.60	-6.64	0.41	1.33	0.92
Electricity	0.65	0.22	-0.43	2.14	1.65	-0.49	1.89	1.77	-0.12
Water	-3.94	-4.14	-0.20	-2.74	-2.98	-0.24	1.29	1.25	-0.04
Construction	-1.55	-2.43	-0.88	-1.50	-2.38	-0.88	0.03	-0.02	-0.05
Trade services	5.77	5.07	-0.70	9.82	8.83	-0.99	0.54	0.16	-0.39
Transport and business services nec.	-13.38	-13.00	0.38	-0.96	-1.39	-0.43	1.82	1.31	-0.51
Communication	-4.13	-4.31	-0.19	-1.60	-1.98	-0.38	-0.20	-0.61	-0.41
Public Administration, Defense, Education, Health	-2.33	-2.30	0.03	-0.26	-0.39	-0.13	-0.84	-1.10	-0.26
Recreational and other services	-7.75	-7.74	0.01	-1.40	-1.86	-0.46	-1.54	-1.80	-0.26
Dwellings	2.01	1.87	-0.13	2.85	2.65	-0.20	-1.79	-2.41	-0.62

Scenario *mig2agr*

	Production quantity			Supply of composite commodity			Purchaser price		
	~_fac	*~_sec*	difference in percentage points	*~_fac*	*~_sec*	difference in percentage points	*~_fac*	*~_sec*	difference in percentage points
Wheat	24.38	32.90	8.52	-1.62	-0.66	0.95	14.01	12.73	-1.28
Cereals	29.42	33.00	3.58	-1.42	-0.52	0.90	14.18	13.99	-0.19
Other crops	58.34	88.98	30.64	6.58	9.56	2.97	-4.16	-10.84	-6.68
Milk	0.45	2.49	2.04	-0.20	1.17	1.37	0.63	-4.43	-5.06
Bovine cattle, sheep, goats, and horses	14.56	18.53	3.96	-0.01	1.27	1.28	3.22	1.24	-1.97
Other animal farming	10.84	15.62	4.79	2.27	3.96	1.69	-1.64	-6.20	-4.56
Fruits and vegetables	17.76	22.79	5.03	0.76	1.67	0.90	-4.83	-8.30	-3.47
Fishing	11.31	13.11	1.80	-0.03	0.81	0.84	-3.87	-4.90	-1.03
Gardening, and mixed, unclassified farming	1.83	3.44	1.61	-0.17	0.53	0.71	0.72	-6.53	-7.25
Coal, oil, and gas	-0.26	-0.03	0.23	0.25	0.66	0.41	-0.19	-0.01	0.18
Minerals nec	-6.57	-8.53	-1.97	-5.46	-7.09	-1.63	-0.19	-0.01	0.18
Meat products nec	0.03	1.21	1.18	-0.03	0.60	0.63	-0.35	-1.87	-1.52
Processing of fruit, vegetables and fish	-0.11	1.38	1.50	0.00	0.35	0.35	-0.23	-0.72	-0.48
Manufacture of edible oils, margarine and oil products	-2.11	-1.21	0.90	-0.73	-0.08	0.65	-0.63	-1.67	-1.04
Dairy Products	-0.31	0.75	1.06	-0.21	0.42	0.63	0.35	-1.77	-2.12
Manufacture of grain-mill products	-2.42	-1.63	0.79	1.90	2.69	0.79	5.68	5.77	0.09
Other food products	-0.76	-0.30	0.45	-0.18	0.06	0.24	0.20	0.01	-0.19
Beverages and tobacco manufacturing	-0.19	-0.08	0.11	-0.11	0.01	0.12	-0.02	0.08	0.10
Textiles	-1.39	-1.32	0.07	-0.52	-0.31	0.20	-0.02	0.19	0.20
Wearing apparel	-0.57	-0.44	0.13	-0.33	-0.12	0.21	0.06	0.30	0.23
Leather products	-0.80	-0.69	0.11	-0.33	-0.12	0.21	0.01	0.23	0.22
Wood products	-2.60	-3.22	-0.62	-2.32	-2.87	-0.55	0.04	0.28	0.24
Paper products and publishing	0.02	0.26	0.24	0.15	0.45	0.29	0.02	0.28	0.26
Petroleum and coal products	-0.35	-0.12	0.23	-0.25	0.01	0.26	-0.11	0.10	0.20

Scenario *mig2agr* (contd.)	Production quantity			Supply of composite commodity			Purchaser price		
	~_fac	*~_sec*	difference in percentage points	*~_fac*	*~_sec*	difference in percentage points	*~_fac*	*~_sec*	difference in percentage points
Chemical, rubber, and plastic products	-1.59	-1.80	-0.22	0.04	0.35	0.31	0.08	0.35	0.27
Mineral non-metallic products	-0.73	-0.66	0.07	-0.47	-0.30	0.17	0.03	0.30	0.27
Basic metal	-1.84	-2.24	-0.39	-1.44	-1.67	-0.22	-0.13	0.08	0.21
Metal products (excl. machinery, equipm.)	-0.73	-0.68	0.04	-0.50	-0.35	0.15	0.06	0.35	0.29
Motor vehicles and parts	-0.63	-0.38	0.25	-0.23	0.10	0.34	-0.09	0.11	0.20
Electronic equipment	-3.87	-5.11	-1.24	-1.25	-1.38	-0.13	0.03	0.30	0.27
Machinery and equipment nec	-1.67	-2.05	-0.37	-0.64	-0.57	0.08	0.01	0.27	0.27
Manufactures nec	-6.20	-8.10	-1.90	-3.65	-4.57	-0.92	0.02	0.28	0.26
Electricity	-0.05	0.25	0.30	-0.03	0.28	0.31	0.01	0.26	0.26
Water	6.12	8.34	2.22	6.15	8.37	2.22	0.03	0.28	0.25
Construction	-0.30	-0.04	0.26	-0.30	-0.04	0.26	0.17	0.36	0.19
Trade services	-0.11	0.17	0.28	-0.03	0.27	0.29	0.13	0.35	0.22
Transport and business services nec.	-0.75	-0.73	0.01	-0.43	-0.26	0.17	0.18	0.54	0.36
Communication	-0.68	-0.51	0.17	-0.63	-0.43	0.20	0.09	0.42	0.34
Public Administration, Defense, Education, Health	-0.16	-0.10	0.06	-0.12	-0.05	0.07	0.07	0.34	0.27
Recreational and other services	-0.61	-0.42	0.18	-0.47	-0.24	0.23	0.08	0.36	0.29
Dwellings	-0.70	-0.58	0.12	-0.67	-0.54	0.14	0.11	0.56	0.45

IV. Labour Market Flexibility and Costs of Adjustment

Dorothee Flaig, Harald Grethe[1] and Scott McDonald

This chapter consists of the correspondent article which is submitted to the *Journal of Policy Modeling.*

Abstract

There is a large empirical literature on the existence of high and persistent costs of intersectoral labour reallocation, an issue only little considered in equilibrium modelling. Neglecting these reallocation costs overestimates the size of labour movements and therefore the possibility of adjustment for an economy, as well as the welfare benefits of policy reforms. In the light of the Palestinian-Israeli conflict, this study addresses the question as to how the existence of labour reallocation costs for movement between sectors influences welfare effects that may accrue from a calming down of tensions, resulting in increasing employment of Palestinians in Israel.

Keywords:

Reallocation Costs, Imperfect Labour Markets, Factor Mobility, CGE-Model, Israel

JEL-Classification:

C68, J62, J24, J42

IV.1. Introduction

It is a well-known issue that the valuation of welfare effects from trade liberalisation and opening of labour markets for foreign workers differs strongly between the economic and public view. This discrepancy originates, in part, from differing views on the labour markets: while economists often assume perfect labour markets with full employment, the reality of costs of reallocation is most apparent to the public (see e.g., Davidson and Matusz, 2000). If costs of reallocation exist, they will inhibit labour movement, hence neglecting reallocation costs should result in an overestimation of the size of labour movements and suboptimal realised benefits. Several empirical studies show that workers who change sectors can experience large and persistent losses in wages. Two effects are primarily responsible for these losses: lower incomes during unemployment and lower wages upon reemployment. The latter is caused by problems associated with transferring skills and the time costs required for skill acquisition and learning processes in the new sector of employment. Thus, the main source of costs is not the loss of a job, as many workers quickly find a new job and thus losses in income and production are limited But reemployment at lower wage rates, because of incomplete skill transfer into the new sector, is a persistent and large problem.

The Israeli and Palestinian labour markets were integrated. Up to 23% of Palestinian workers crossed the border to work in Israel, mainly in unskilled jobs in agriculture and construction. With the outbreak of the Second Intifada in 2000, this situation changed: the border was closed, causing severe unemployment in Palestine. Israel substituted the Palestinian workers with other foreign workers coming from the rest of the world (ROW). A study conducted by Flaig *et al*., (2013) found positive welfare effects for both economies, Israel and Palestine, when lifting the movement restrictions and increasing Palestinian employment in Israel. With the empirical evidence for the existence of labour movement costs a question arises: to what extent the Israeli unskilled workers can move out of the construction and agricultural sectors and if they are really able to benefit from the new situation. This study tracks the wage losses from factor reallocation accruing to workers and identifies the impact of these losses on the total economy and welfare.

This study incorporates the skill losses of intersectoral labour reallocation into the computable general equilibrium (CGE) model STAGE. The data employed are provided by a Social Accounting Matrix (SAM) for Israel in 2004 (Siddig *et al*., 2011). In addition to skill levels, labour groups are segmented by sector block of employment. Movement of labour between segments is determined by changes in relative wages and governed with a migration function. The model allows for the choice between sector or factor specific productivity. In this study, the effects of reallocation costs found in empirical studies are disentangled from the productivity effects of labour reallocation by controlling for labour productivity effects. The results show, that reallocation costs and the mobility setup matters for model outcomes. Positive welfare effects are lower with increasing reallocation costs/decreasing mobility and the realisation of benefits is suboptimal.

The next section reviews the empirical and modelling literature on the costs of intersectoral labour reallocation, while section 3 describes the model and data. Section 4 defines the scenarios analysed and presents and discusses results. Conclusions are drawn in the final section.

IV.2. Adjustment Costs of Intersectoral Labour Migration and Simulation Modelling

Several empirical studies show, that workers who change sectors can experience large and persistent losses in wages. In a study on wage losses of displaced workers, applying 1980s data from Pennsylvania with a focus on high tenure workers, Jacobson *et al*., (1993) find that wage losses of workers who change the sector, e.g., leave the manufacturing sector, account for 38% of their pre-displacement earnings. Workers who find new employment inside the manufacturing sector experience losses of 18-20%. This also holds if workers find new jobs inside the same four-digit industry. In a more recent study for the US with data between 1990-2005 the average wage loss for displaced workers accounts to 15.5%, where workers who switch industries experience an even larger loss of 20.8%, while others who remain in their former industries experience a wage loss of 5% (Figura and Wascher, 2010). Thus, earning losses are 16-20% higher upon reemployment in other sectors compared to reemployment in the old sector (Fallick, 1996). The considerably higher numbers found by Jacobson *et al*., (1993) may have been caused by the focus on high skilled workers. High skilled workers are most likely to possess firm-specific and accumulated human capital and are therefore more affected when changing firm. Despite some differences in assessing the level of the wage losses, there is consent on considerable differences for wage losses between reemployment in the old industry and reemployment in a new industry. These earning losses are persistent (Jacobson *et al*., 1993, Fallick, 1996, and Figura and Wascher, 2010). Earnings drop sharply when leaving the job and rise rapidly again in the next 1.5 years. After 1.5 years the increase becomes very slow and after 5 years losses of 25% of pre-displacement earnings have been reported (Jacobson *et al*., 1993). Furthermore, wage losses depend only marginally on age and sex and are not only limited to a few sectors. Local labour market conditions are crucial: losses are larger, when workers are displaced in regions with depressed rates of employment growth. The difference between strong and weak labour markets accounts for one third of the average loss (Jacobson, 1993). Cyclical conditions have substantial and long lasting effects, too, but even workers displaced in a strong labour market are found to experience large wage losses.

Using data for 15 industries and 16 countries covering 8 years, Gramm (2005) estimates the level of factor specificity of labour and capital in different sectors and for different time periods. The study found a significant level of factor specificity and that factors are not perfectly mobile, with capital being more specific than labour.

There are two different reasons why a worker changes her job: first, a worker chooses to reallocate among a given number of jobs; and second, the distribution of jobs alters, resulting in the need to reallocate. In the first situation, the worker will only change her job if she will be able to or at least expects to maintain her level of income. The situation considered in this study applies to the second situation, where labour reallocation is induced by the demand side due to macroeconomic changes, e.g., in international trade, technology or politics (Gonzales Uribe, 2006, and Fallick, 1996).

As indicated, the main reason for wage losses is firm- or sector-specific human capital. In addition, workers might have been especially suited in skills for their former job, because of particular good matches from intensive search, what cannot be realised after reemployment and causes wage losses after reemployment (Fallick, 1996 and Jacobson *et al.*, 1993). Other reasons are the loss of wage premiums and the loss of seniority, more specifically, lower long term earnings regarding the career when starting with a lower wage in expectation of a higher wage in the future. In an empirical study on inter-industry mobility of Jewish immigrants in Israel, Darvish (1990) identified four variables, which are relevant for imperfect labour mobility between industries. First, labour market experience goes together with greater industry specific skills; age is therefore correlated with lower inter-industry mobility (Arrow, 1962). Second, according to the human capital theory of Becker (1962), the worker's level of education serves as approximation of the skill-level: the higher the skills level the higher is the worker's value for the employer and the cost of inter-industry mobility. Third, mobility depends on the status at work: (former) self-employed are more reluctant to change industries than employees because of higher skills, assuming that people deciding for self-employment are particular competent. And fourth, in addition to sector specific skills, labour mobility depends on the settlement region: settlement in economic active areas is negatively correlated with the inter-industry mobility rate. This is because of the higher number of economic opportunities as well as because of the higher availability of information and therefore more intensive search, which increases the probability of finding a job in the old industry.

The costs of labour reallocation were included in a modelling framework by Garcia-Cebro and Varela-Santamaria (2011), using a new open economy macroeconomics (NOEM) model with two sectors: one tradable and one non-tradable which is monopolistic competitive. Imperfect mobility is modelled by including the cost of reallocation and leisure in the household utility function. Simulating a monetary expansion in a small open economy, there are less expansionary effects on (traded) output (short term) and less contractionary effects in the long term as well as less welfare in the long run, when assuming imperfect labour mobility. The results of the previously mentioned studies are supported by Tapp (2011), who estimates the costs of sectoral labour adjustment with an equilibrium search and matching model. The study on Canada's sectoral labour adjustment in 2002-2006, a period of increasing commodity prices and exchange rate appreciation, which led to significant movements of labour out of the manufacturing into the resource sector, found adjustments costs up to 3% of output during the first three years. Non-transferability of skills was the predominant contributor to these aggregate costs, which generally remained for up to five years.

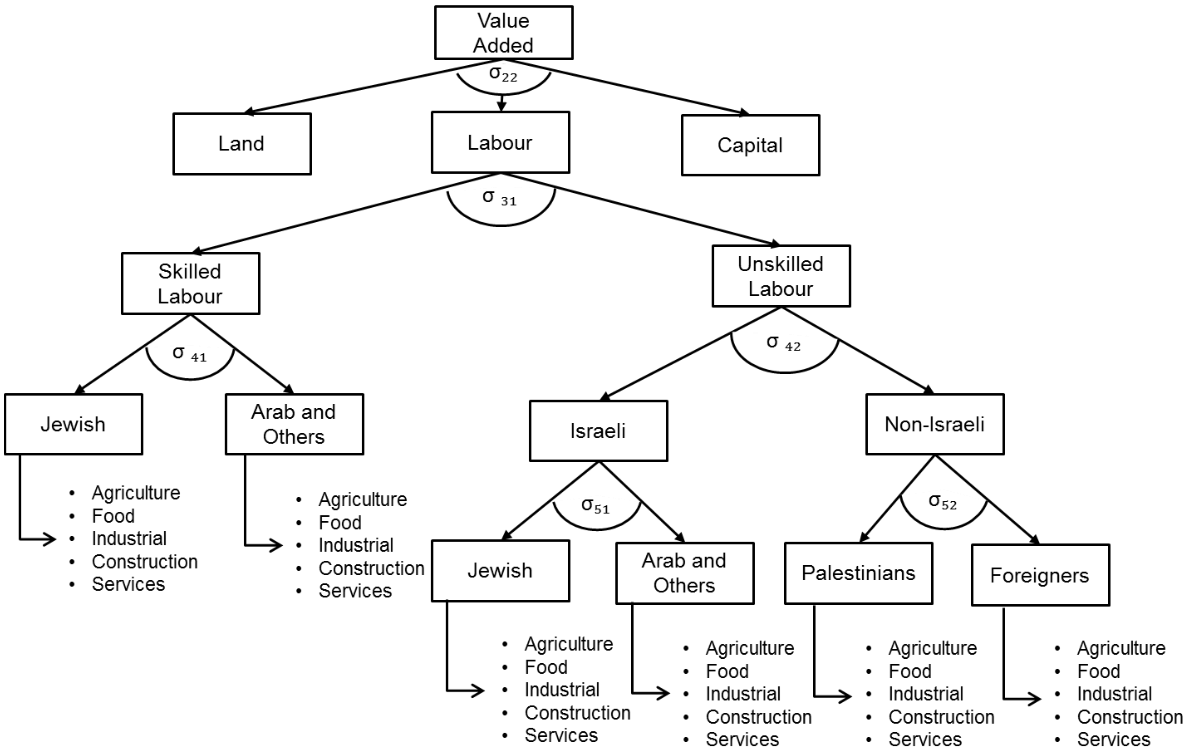
The existence of labour reallocation costs is crucial, when estimating the adjustment of economies to globalization and trade liberalization. It appears that public and economic opinions are strongly divided on the issue of whether there are welfare gains from trade liberalisation. This difference is due to the view on the labour market: while economists assume a fully-employed, perfectly mobile labour market, the reality of unemployment is most apparent to the public (Davidson and Matusz, 2000). The true effects seem to be somewhere in between: economies that have the least to gain are those with sluggish labour markets, while economies with either very flexible or very sluggish labour markets show clear net benefits from trade liberalisation (Davidson and Matusz, 2000). In a very flexible economy, adjustment to trade liberalisation occurs swiftly, while adjustment costs are high in an economy with sluggish labour markets but such economies also realise higher benefits from liberalisation as the distorting effects from tariffs are large. An economy with moderately sluggish labour markets has least to gain, because adjustment occurs relatively slowly and the distortionary effects from tariffs are not that large.

Despite the empirical evidence for their existence, labour reallocation costs are usually not accounted for in CGE-models. Typically workers are assumed to move either freely, without costs, between sectors or not at all. Chan *et al.*, (2005) consider adjustment costs in labour markets in a static CGE-study for Vietnam. Imperfect labour movement is implemented with a constant elasticity of transformation (CET) function, and transaction costs are implemented as 10% relocation costs on the value of labour movements, assuming a *de facto* reduction in factor endowment. The findings of Chan *et al*., (2005) suggest that the amount of labour movement between sectors is typically overestimated and that distributional impacts are intensified by transaction costs. The CET approach relocates factors according to a productivity frontier and labour quantities are no longer measured in 'natural' units. This makes the labour market clearing conditions vague. To overcome this problem, this study choses a migration function approach to differentiate between quantities and wages and define relocation costs as reductions in wages. Furthermore, we are able to isolate transaction costs effects from productivity effects from the migration of workers between sectors with different productivities.

IV.3. Model and Database

This study uses an augmented version of the STAGE model (McDonald, 2009)[15], which is calibrated using an Israeli SAM of the year 2004 (Siddig *et al*., 2011), that was politically a relatively calm year. The SAM has 42 commodity and activity accounts, ten household groups that are classified by ethnicity (Jewish, and Arab and Others) and income quintiles, four Israeli labour types defined by skill level and ethnicity, and two types of foreign labour - Palestinians and Foreigners, i.e., migrant workers from the rest of the world. For each type of labour there are data on the transactions values and quantities used by each activity.

Figure IV.1. Value Added Nesting



[15] STAGE is a member of the class of CGE models that derive from the USDA/ERS model from the early 90s (Robinson *et al.*, 1990). See McDonald (2009) for a technical description of the base model.

The data demonstrate substantial differences in the implied wage rates for each labour type according to the employing activity. To represent this heterogeneity, each labour type, e.g., 'unskilled Israeli Arab and Others', is divided into five segments based on the activity blocks that employ the labour: agriculture, food, manufacturing, construction and services. Each labour type is assumed to be perfectly mobile within each activity block, but imperfectly mobile between activity blocks. Labour mobility between blocks is controlled by (labour) migration functions where the degrees of mobility are controlled by (supply) elasticities that govern the responsiveness of migration to changes in relative wages.[16] This approach allows the modeller to distinguish between the stock of each labour type, measured in physical numbers of workers, and the flow of services realised from each worker in each activity. Market clearing conditions are defined by reference to the stocks of labour, but the reallocation of labour between activities might change the flow of labour services available to an economy. In addition, adjustment parameters are included, that allow the realised productivities for relocating labour types to be changed; this represents the costs associated with changing employment patterns.[17]

The model therefore provides the user with three additional instruments to control the operation of the labour markets. First, the user can control the stock-flow relationship for each labour type, e.g., does a migrating worker keep her productivity from the initial activity or adopt that of the destination activity; second, the user controls the flexibility of the labour market by setting the migration elasticities between activity blocks[18]; and third, the setting of the adjustment parameters determines the (assumed) costs of relocation.

IV.4. Simulations and Results

IV.4.1. Simulations

Two scenarios are run to estimate the effects of a reduction of movement restrictions for Palestinian workers in Israel:

a. The base scenario replicates the Israeli SAM for 2004 and thus reflects a restrictive Israeli border measure against Palestinians, therefore 7% of Palestinian employees from the West Bank are employed in Israel.
b. The policy scenario simulates a liberalised Israeli labour market policy. The share of Palestinian workers from the West Bank who work in Israel is increased from 7% to the pre-Intifada level of 26%. Wages in Israel are 70% higher than those Palestinians receive in Palestine (PCBS, 2011). This, in combination with high unemployment, over 18% (PCBS, 2011), means Palestinian labour supply is assumed elastic and it is assumed that Palestinians are willing to work in Israel even when wages decrease.

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[16] A detailed description of the migration function and the modelling of factor specific productivity can be found in Flaig *et al.* (2013a).
[17] In a dynamic formulation the adjustment parameters can change over time, reflecting an assumption that they reflect short term adjustment costs.
[18] If the elasticity is set to zero, the migration function for that factor and activity block pair is switched off.

Labour reallocation has two different effects: first, in standard models the moving worker adopts the new sector's productivity, which influences *de facto* factor endowment of the economy and thus effects simulation results. Second, there are transaction costs of labour reallocation. In order to disentangle productivity effects from the transaction costs, migrating workers are assumed to keep the level of productivity of their sector of origin, which eliminates the productivity effect. Thus, the average sectoral productivity of each labour type will change with migration.

If labour is homogeneous and perfectly mobile, the data should report similar wage rates in industries for a specific labour category, whereas the data reports strongly differing wage rates between industries. Wages differ markedly between sector blocks and are less differentiated within a sector block. Accordingly, we assume, that wage differences for a specific labour category inside a sector block originate from, *inter alia*, differing capital-labour ratios rather than from differences in specific skills. While differences between sector blocks originate from sector block specific skills, which render labour imperfectly mobile and cause reallocation costs. Thus, labour is fully mobile inside a sector block and imperfectly mobile between sector blocks.

The objective of this study is to investigate, how Israeli unskilled workers adjust to the increased labour supply. For this purpose, the policy scenario (b) is run with two variations in the mobility setup and with and without reallocation costs. Labour is assumed to be either highly mobile or virtually immobile; if labour is mobile it may or may not incur reallocation costs while if labour is virtually immobile reallocation costs are high enough to prevent migration. Thus the three labour market setups are:

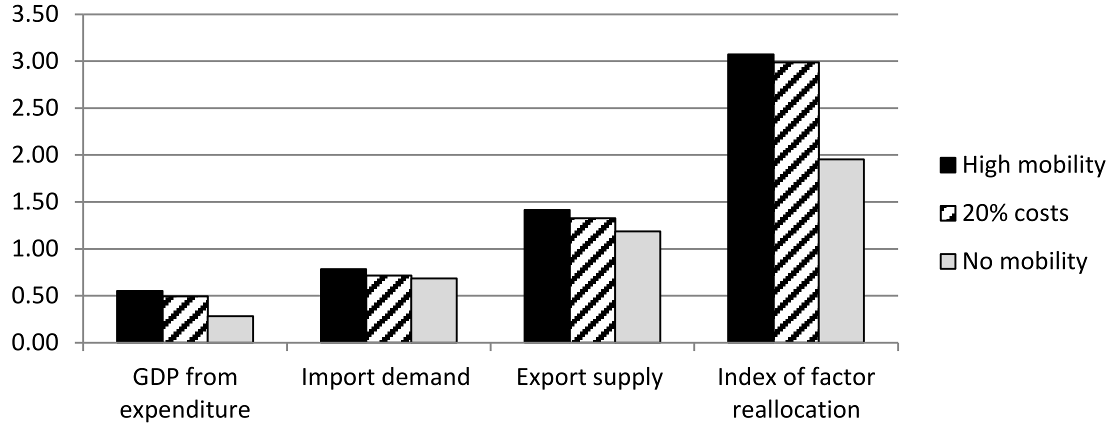
1. *High mobility*: A high migration elasticity (ε_{mig}=6) allows for strong labour reallocation between sector blocks after changes in relative wages; no reallocation costs are assumed.
2. *20% costs*: The second setup reflects a situation when workers who are reallocated between sector blocks experience a 20% cut in wages. Productivity is fully factor specific and reallocated workers' wages as well as productivity decline by 20% compared to their former earnings/productivity.
3. *No mobility*: Finally, the third setup represents a situation where labour is immobile, i.e., the labour migration is completely inelastic. As there is no labour reallocation taking place, the 20% reallocation costs are irrelevant.

The macroeconomic closures applied are investment driven savings and the foreign account being cleared by the exchange rate. Furthermore, the government balances its account with a tax replacement instrument: the income tax rate is the equilibrating variable. The CPI serves as numéraire. Factors are fully employed with fixed factor supply for each factor type and fully mobile with the exception of labour being imperfectly mobile between sector blocks.

IV.4.2. Results and analysis

The opening of the Israeli labour market to Palestinians increases domestic production and enhances economic growth. When considering distributional effects, private household incomes decrease, but declining living costs mitigate this effect and all household groups benefit while the income gap widens.

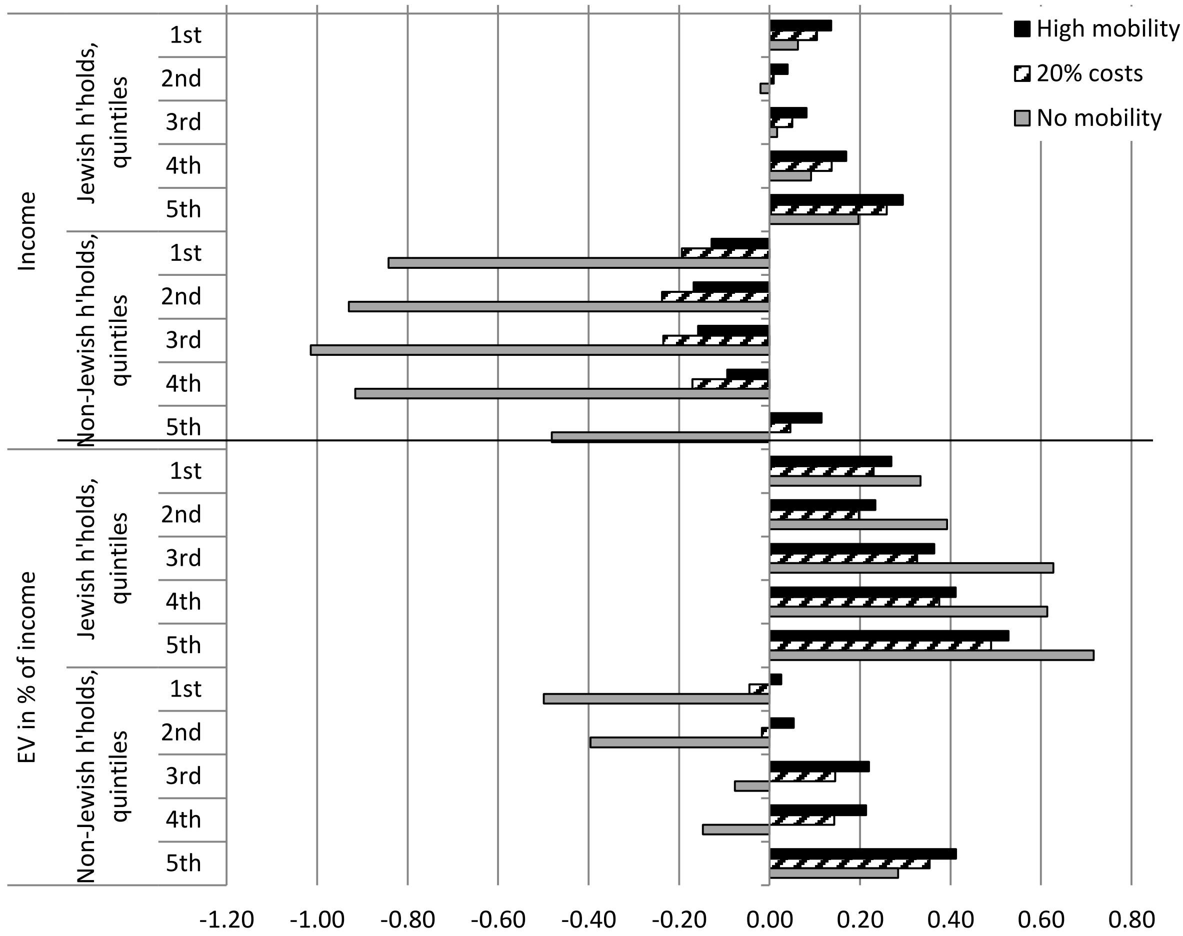
Figure IV.2. Macroeconomic Effects



GDP increases in all mobility setups, but to a smaller extend, the higher the transaction costs are (Figure IV.2). The same is observable when considering household income, higher transaction costs decrease positive effects on household income or increase negative effects (Figure IV.3). Not so clear are the effects when examining household welfare, measured by the equivalent variation (EV), which combines household income with household expenditures. While the change in EV, depicted in % of household income, is lower for all households in the situation with *20% transaction costs* compared to the situation with *high mobility*, the effects from the situation with *no mobility* are ambiguous. To explain these ambiguous effects, first income effects and second household expenditures are analysed.

Increased employment of Palestinian workers, which are mainly employed in unskilled jobs in Israel, increases unskilled labour supply. Wages of unskilled and skilled non-Jewish labour types decrease, while average wages of skilled Jewish labour, capital and land increase (Table IV.1). Foreign workers and Palestinian workers represent a large share of employees in agriculture and construction, Israeli skilled and unskilled labour types move out of these sector blocks and into services, skilled labour types move also into manufacturing. Foreigners from ROW, which are direct substitutes to Palestinian workers, show a different movement. Because the increase of Palestinians in construction is strongest, with 9% of all employees being Palestinian in the base scenario, the movement of foreigners from ROW out of construction outweighs movement from agriculture to other sectors. There are more foreigners moving from construction into agriculture than out of agriculture, causing a net inflow of foreigners into agriculture. The strong outflow from foreigners in food and industrial sectors, about 25%, has to be related to a very small base and is caused by a relatively high number of Palestinians in the base scenario compared to ROW-foreigners. Increasing costs of reallocation decrease factor reallocation between sectors, displayed as index of factor reallocation in Figure IV.2, which shows aggregated reallocation of all factors, including capital and land, in relation to aggregated factor demand. *20% transaction costs* of labour reallocation decreases overall migration and decreases wages for most labour types. In the third setup with *no mobility,* there is no migration, and reallocation is only possible within a sector block. The effects on wages are greater in both directions: wages increase, where workers would move in, and decrease, where they cannot move out.

Figure IV.3. Distributional Effects on Household Groups, Income and EV in % of Income



The effects of the liberalisation of the labour market on household incomes are more positive or less negative the richer the household group is. The explanation is, that poor household groups own a higher share of unskilled labour, where wages decrease, compared to richer households, which have higher shares in the complementary factors - capital, land and skilled labour - for which wages rise or decline less. Exceptions are the poorest quintiles whose income consists mainly of transfers, which are fixed in real terms for governmental transfers and transfers from abroad. However, inter-household transfers are flexible and depend on the disposable income, which increases for Jewish and rich Arab-Israeli households, thus, inter-household transfer payments increase. All non-Jewish households show clearly less positive or more negative income effects compared to the Jewish household groups. The reason for this is that non-Jewish households supply a higher share of their labour to agriculture and construction, where wages decline strongest. This is valid for skilled as well as unskilled workers.

Household expenditure is another element affecting household welfare. Decreasing wages have two contrary effects on welfare: on the one hand, household incomes decrease, and on the other hand, production costs potentially decrease affecting consumption prices, which finally results in a falling cost of living. The responses to the simulation of the five sector blocks – agriculture, food, manufacturing, construction and services – are different.

Table IV.1. Factor Change (Migration) and Wage Change in %

			Factor Supply			Wages		
			High mobility	20% costs	No mobility	High mobility	20% costs	No mobility
Skilled Israeli	Jewish	Agriculture	-2.13	-1.78	0.00	0.02	0.00	-1.37
		Food	-0.27	-0.15	0.00	0.07	0.05	-0.47
		Industry	0.68	0.65	0.00	0.20	0.17	0.61
		Construction	-3.69	-3.80	0.00	-0.03	-0.06	-9.07
		Services	0.14	0.14	0.00	0.20	0.17	0.47
	Non-Jewish	Agriculture	-0.89	-0.75	0.00	-0.29	-0.37	-1.43
		Food	0.78	0.77	0.00	-0.25	-0.33	-0.47
		Industry	1.29	1.21	0.00	-0.16	-0.25	0.54
		Construction	-2.84	-2.80	0.00	-0.32	-0.40	-9.07
		Services	0.69	0.69	0.00	-0.12	-0.20	0.44
Unskilled Israeli	Jewish	Agriculture	-5.75	-4.05	0.00	-4.08	-4.02	-4.52
		Food	-4.92	-5.07	0.00	-4.09	-4.10	-7.48
		Industry	-1.90	-1.98	0.00	-3.82	-3.84	-4.96
		Construction	-13.83	-14.24	0.00	-4.35	-4.37	-17.62
		Services	1.51	1.44	0.00	-3.24	-3.28	-1.87
	Non-Jewish	Agriculture	-3.19	-1.73	0.00	-4.64	-4.71	-4.60
		Food	-2.84	-3.18	0.00	-4.67	-4.79	-7.44
		Industry	-0.76	-0.96	0.00	-4.47	-4.60	-5.19
		Construction	-12.34	-12.48	0.00	-4.89	-5.01	-17.62
		Services	2.46	2.40	0.00	-3.87	-4.00	-2.09
Foreign workers from ROW		Agriculture	8.22	6.97	0.00	-8.36	-8.77	-6.04
		Food	-26.60	-24.70	0.00	-9.70	-9.99	-17.62
		Industry	-22.51	-21.34	0.00	-9.56	-9.88	-15.71
		Construction	-11.94	-11.38	0.00	-9.05	-9.40	-20.71
		Services	5.74	5.72	0.00	-7.96	-8.34	-4.43
Palestinian		Agriculture	270.00	270.00	270.00	-31.68	-30.83	-29.74
		Food	270.00	270.00	270.00	-36.96	-36.81	-38.40
		Industry	270.00	270.00	270.00	-36.10	-36.10	-36.98
		Construction	270.00	270.00	270.00	-33.92	-34.06	-40.71
		Services	270.00	270.00	270.00	-29.77	-29.63	-28.86
Capital			0.00	0.00	0.00	0.67	0.60	0.46
Land			0.00	0.00	0.00	0.78	0.71	0.73

Agricultural sectors as well as construction can realise strongly declining wages, reflected in the prices of value added, which dominate the effects on producer and purchaser prices (Figure IV.4). While the price decreases become smaller with increasing transaction costs in the agricultural sector block, construction experiences a drop in the price of value added of 2% in *high mobility* and a strong drop of 9% in *no mobility*. These price developments are determined by the average wage in a sector and thus the composition of its factor demand. Workers in construction are most affected by the inflow of Palestinian workers and thus the wages in construction are also the most sensitive to labour mobility (Table IV.2). While reduced mobility results in decreased outflows of workers out of construction, in agriculture this means reduced inflow of workers and thus price effects become smaller. Prices also decrease for food products, although to a smaller extent. The price effects are small and positive for most of the manufacturing goods and services activities.

Table IV.2. Changes in Total Labour Supply per Sector Block, in %

	Including Palestinians			Excluding Palestinians		
	High mobility	20% costs	No mobility	High mobility	20% costs	No mobility
Agriculture	10.56	10.58	10.03	0.55	0.57	0.00
Construction	4.36	4.43	4.82	-0.46	-0.39	0.00
Food	5.68	5.65	5.20	0.49	0.46	0.00
Industry	19.20	19.31	24.94	-6.32	-6.20	0.00
Services	2.91	2.90	2.32	0.60	0.59	0.00

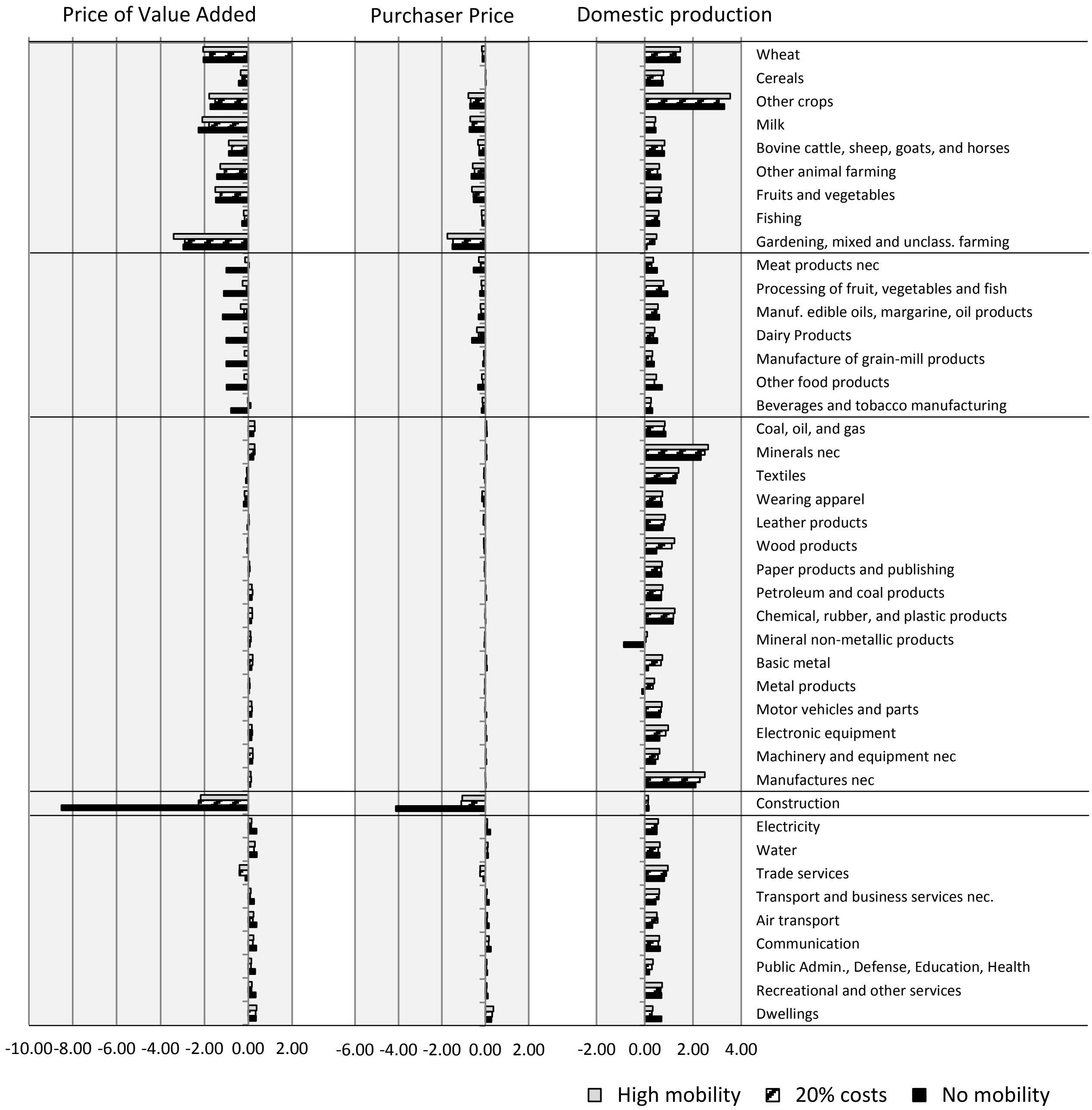
Concerning the production quantities, the sector blocks show similar effects, production increases in most of the sectors, but with increasing transaction costs the effect is smaller. The strong price decline in agriculture and construction is reflected in a rather moderate increase in demand, caused by low elasticities of demand for these goods. The production increase in manufacturing is relatively strong compared to the small and even positive price developments. These sectors, which typically have a high share of production exported (up to 62% in Manufactures nec.), benefit from the increased competitiveness on international markets. Exports increase by 1.2-1.4% (Figure IV.2), led by a depreciation of the currency of 0.07%. Increased employment of Palestinian workers in Israel implies increased outflow of remittances to Palestine, the Israeli currency depreciates to maintain a balanced current account. Increased demand for services products, mainly by rich households who experience an increase in real income due to higher factor income and decreasing product prices, increases production despite increasing prices in the services sector block.

Thus, the ambiguous effects on the welfare of different household groups in a situation with *no mobility* can be explained by differences in the factor endowments of the household groups. The Equivalent Variation (EV) combines income and price effects, households benefit from, on average, decreasing prices but experience income losses. These income losses originate especially from workers, who would adjust to a shock and are hindered in migration, due to the reallocation costs, and hence experience greater wage losses. Thus the decrease in purchaser prices is not strong enough to fully mitigate negative income effects in Arab and poor Israeli household groups.

To conclude, the introduction of *20% reallocation costs* implies a loss to the economy for each worker who migrates, which negatively affects all agents in the economy, compared to the situation without costs. In addition, and what is more evident with no migration (*no mobility*), households who own labour that should react to the shock but cannot migrate, are affected most negatively. This implies that increasing inter-sectoral reallocation costs in Israel widens the gap between the poor – who own a larger share of unskilled labour which is most negatively affected[19] – and the rich.

[19] Palestinians, whose number increase, are employed in Israel mainly in unskilled jobs and thus directly compete with Israeli unskilled and other foreign workers for jobs.

Figure IV.4. Production, Price of Value Added and Purchaser (Producer) Prices, % Changes.

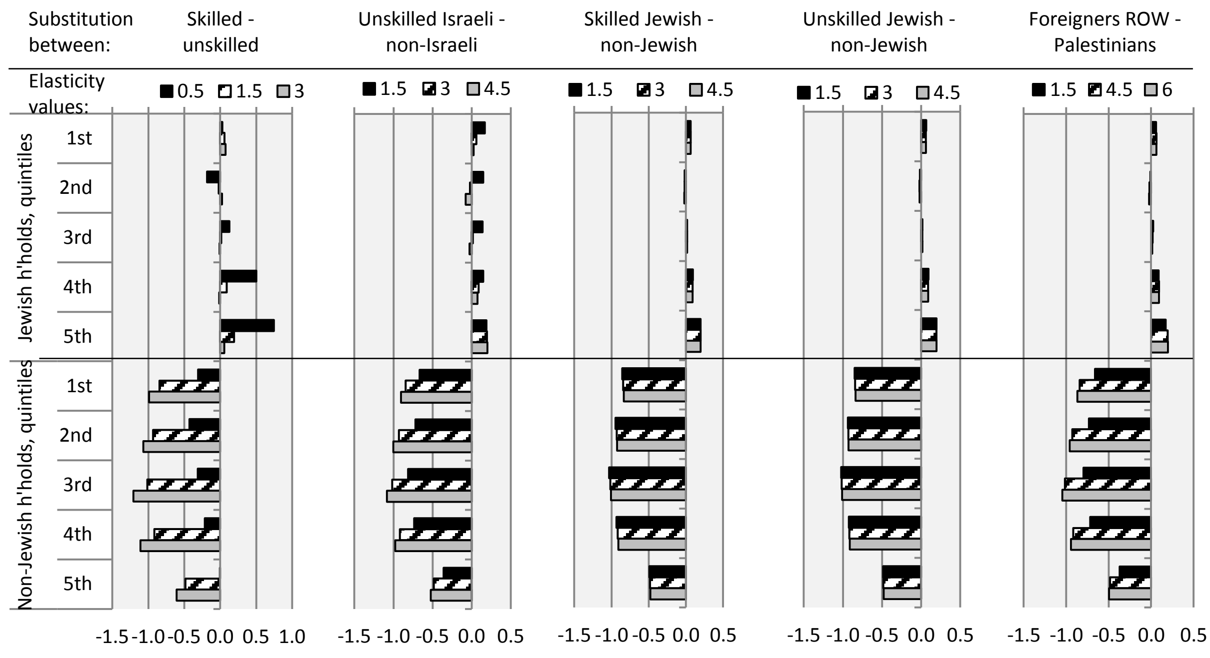


IV.4.3. Sensitivity Analysis

The model employs two sets of elasticities, which might influence the results and are thus systematically analysed. These are first, the substitution elasticities governing responsiveness in the labour nesting and second, the migration elasticities.

A systematic analysis of each of the substitution elasticities (σ, Figure IV.1) shows, that a variation in the substitution elasticities has only small effects on production, the macro economy and private household incomes. Figure IV.5 displays results for household income under different substitution elasticities in different production nests. A lower substitutability between skilled and unskilled workers further increases the income inequality enhancing effect of labour market integration. Furthermore, a lower substitutability between unskilled Israelis and non-Israelis improves results for all household groups. A lower elasticity between Jewish and non-Jewish Israelis (both skilled and unskilled) improves effects for non-Jewish Israeli households and reduces positive effects for Jewish Israeli households.

Figure IV.5. Effects of Substitution Elasticities on Results on Household Income, Different Elasticities and Elasticity Values, High Mobility Scenario



The second relevant set of elasticites are the migration elasticities, which govern the response of labour migration to relative wage changes. A detailed analysis for values between 0.5 and 12 shows that the level of the elasticity is not relevant for the main conclusions drawn from the results; namely, any reduction in the degree of labour mobility reduces the potential benefits from expanding the pool of labour and there is no evidence, that any degree of reduced mobility of labour is beneficial.

IV.5. Conclusions

There is a large empirical literature on the existence of intersectoral labour reallocation costs. Workers who change sectors can experience large and persistent losses in wages. The main reason for wage losses is firm- or sector-specific human capital. These costs are typically not accounted for in CGE modelling, which results in an overestimation of adjustment processes in the economy and related sectoral as well as macroeconomic impacts on simulation results.

In order to quantify the relevance of these transaction costs at an economy wide level, this study applies a CGE model to simulate liberalisation of the Israeli labour market policy against Palestinians with three different setups of labour mobility: high mobility, migration with 20% costs and with prohibitive costs preventing migration. This scenario increases Palestinian employment in Israel by 370% to a historic level from 2000, when 26% of all Palestinian employees were working in Israel. Increased labour supply induces economic growth and increases welfare for all households in Israel, though income effects are greater for rich households.

Results from the different mobility setups show, that labour reallocation costs matter, especially for the analysis of distributional effects. Reducing mobility and/or increasing transaction costs decrease the positive effects accruing from the liberalisation of the Israeli labour market for Palestinians. This is reflected in lower economic growth, affecting nearly all sectors of the economy. The scenario employed causes labour reallocation between sector blocks. Reducing mobility and/or increasing transaction costs inhibits the ability of workers to adjust to shocks in the labour market, which results in increased wage and thus income effects. Those workers who would optimally seek to move out of a sector are negatively affected. In this study, these are employees in agriculture and construction, sectors were wages are below average. Thus, taking into account factor reallocation costs further increases the gap between rich and poor households in the economy and reduces positive growth effects to the Israeli economy.

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V. Synthesis and Outlook

V.1. Homogeneous and Heterogeneous Production Factors

There are various dimensions in the labour market which can be used to differentiate between groups of workers; these dimensions are, e.g., skill level, age, region, ethnicity or sector of employment. Accordingly, the labour market can be split by specific characteristics of these dimensions into factor types, e.g., in the dimension skill level the characteristics might be highly skilled, semi-skilled and unskilled workers or in the sectoral dimension one might wish to differentiate between agricultural, manufacturing and services workers. The depiction of labour mobility in CGE models is strongly related to the assumption of homogeneity or heterogeneity of factors in specific dimensions. If a factor is assumed homogeneous in a dimension, it is perfectly mobile and perfectly substitutable between the characteristics of this dimension. Accordingly, when wages increase for one labour type, factor demand will substitute the more expensive labour type with another labour type or workers move into the better waged labour type. Thus, adjustment processes lead to equal wages among homogeneous factors. If wages differ constantly between factor types, these adjustment effects are disrupted: factor demand cannot perfectly substitute between labour types, and workers cannot easily move between labour types, hence labour types are heterogeneous.

In CGE models, homogeneous labour is reflected in one labour type while heterogeneity is induced by splitting labour into different labour types[20]. When labour is differentiated into labour types, workers cannot move between the labour types, unless there is an additional feature which makes it possible to transform workers with one characteristic into another characteristic, e.g., an unskilled worker is transformed into a medium skilled worker. This transformation can be implemented with a CET-function (e.g., Ivanchovichina and Martin, 2004, and Valenzuela *et al*., 2008) or a migration function (e.g., McDonald and Thierfelder, 2009). Inside a labour type, workers are fully mobile and, theoretically consistent, should face equal wages. In the production process, factor demand is met by variations in the use of specific factor types and substitution between factor types. Factor types are often not differentiated sectorally. Thus, if the use of a specific factor type is adjusted, e.g., wheat production demands more skilled labour, this skilled labour is sourced from other sectors (or other dimensions where labour is assumed homogeneous). Again, in order to stay theoretically consistent, if there is perfect substitution and labour is assumed homogeneous, wages should be equal between these perfect substitutes.

Imperfect Substitutability between Labour Types: Empirical Validation of Behavioural Parameters versus Representation of Real World Data and Market Structure

[20] Heterogeneity can also be introduced by making factors fully immobile in the model, but that only allows for heterogeneity within the dimensions the model spans, i.e., between sectors or regions, which is presented later in the section.

When wages of different factor types are not equal, these factor types must be imperfect substitutes. Imperfect substitutability between labour types is implemented with constant elasticity of substitution (CES) functions, which combine production factors to form output. The degree of substitutability is governed by the related substitution elasticity. Perroni and Rutherford (1995) proof the flexibility of a nested CES production process. The CES is non-negative and homogeneous of degree zero in prices, furthermore, and in contrast to other flexible functional forms (e.g., the Generalized Leontief form of Diewert, 1971), it is globally regular, i.e., non-decreasing and concave in prices in the whole price space. The global regularity is important, because the search paths algorithms employ to find the equilibrium can involve points which are far from the equilibrium point (Perroni and Rutherford, 1995).

The labour market can be differentiated in multiple dimensions. The different dimensions can all be organised in one single nest. Alternatively, factor demand can be set up as system of nested CES functions. For the studies included in this thesis, the labour demand of Israel is depicted by a four level nested CES functional form, with labour differentiated according to the dimensions skill level and ethnicity, which is described in detail in article 1 on '*Relaxing Israeli Restrictions on Labour: Who Benefits?*'. Palestinian and foreign workers are employed in unskilled jobs in Israel and are not represented in the skilled labour market in Israel. Therefore, aggregate skilled labour can only be sourced from different ethnically defined Israeli skilled labour types (PCBS, 2005). Aggregate unskilled labour can be either Israeli or non-Israeli, which reflects the segmentation in the Israeli labour market. As with skilled labour, the Israeli unskilled labour aggregates are made up of Jewish and Arab & Other workers resident in Israel. The non-Israeli unskilled labour aggregates are made up of Palestinian and foreign unskilled workers, which reflects the fact that Palestinian and foreign unskilled labour are in 'direct' competition while, for instance, Jewish and Palestinian unskilled labour are in less 'direct' competition. Segmentation within the categories of Israeli labour, skilled and unskilled, is necessary for there is recognition that in Israel ethnicity affects employment. This is partly due to service in the Israeli Defence Forces (IDF) (OECD, 2010a, b); Jewish Israelis (with the exemption of the religious Haredim) serve for two to three years in the IDF, while Arabs generally do not serve. Those who serve in the IDF are supported with privileges in the labour market (OECD, 2010c).

The substitutability in each nest is governed by substitution elasticities, which have been set relative to the substitution elasticity for skilled and unskilled labour applied in the GTAP model (Hertel 1997), based on expert judgement. This vague setting is caused by the fact that hardly any estimation for these labour demand parameters exists, which is a major critic of Boeters and Savard (2013) on the use of nested CES functional forms in general. Boeters and Savard (2013) see another problematic point arising from the setup of the nesting hierarchy: traditionally, good substitutes are grouped on the higher levels and substitutability decreases when going down the nested production tree. This traditional convention is not based on empirics and finally the only criterion which counts, is to choose a structure, which fits the data and knowledge about market structure best. Thus the base problem is the conflicting poles: representation of the data and structure of the economy on the one hand and the need for considerably more parameters, which are hardly available, on the other hand. In this model, the representation of real world data and structure is the dominant motivation, and the nesting developed is believed to give a reasonable picture of the true structure of the Israeli labour market. Concerns relating the ad hoc setting of the substitution elasticities are dealt with by systematic sensitivity analyses in all three articles.

V.2. Transformation and Imperfect Mobility

While labour types are used to be differentiated by dimensions such as skill, age or gender, a sectoral disaggregation is very uncommon, although data shows significant wage differences between the sectors of an economy for notionally the same factor type. These differences are typically accounted for in CGE-models with sector specific productivity/efficiency factors. These sector specific efficiency factors allow the model to fit the data, but they do not explain why these differences exist. The reluctance to distinguish labour types by sector accrues from the loss of mobility and the loss of adjustment possibilities of the model, which are connected with the disaggregation in the sectoral dimension. Usually, heterogeneity is assumed between labour types and homogeneity within a labour type. Accordingly, there is typically no or only restricted transformation/mobility between the labour types and perfect mobility is assumed inside a labour type. The specific issue with the sectoral dimension accrues from the production process itself, which, by nature, distinguishes between different sectors. These sectors employ the sector specific labour types. A sector simultaneously demands several skill levels (or labour types of other non-sectoral dimensions) and thus has the possibility to adjust demand by substitution. At the same time, workers of a skill class are employed in several sectors: if factor demand increases in one sector, it is sourced from another sector. If labour types are distinguished on the sectoral dimension, there is no possibility to substitute between factor types of the sectoral dimensions and factor demand is fixed, unless there is a possibility to transform workers from one sector into a worker of another sector[21].

Transformation between labour types, also known as imperfect mobility, is typically included in CGE models with a Constant Elasticity of Transformation (CET) function. In the GTAP-model family imperfect mobility of land between agricultural sectors, modelled with a CET function, is a standard feature (e.g. Golub *et al.*, 2006, Ahmed *et al.*, 2008 and Li *et al.*, 2012)[22]. In a study for Israel and Italy, Palatnik *et al*. (2011) estimate CET elasticities, based on simulations with a regional scale PMP land-use model, and apply these estimates to a CGE model, in which land supply is modelled with nested CET functions. Imperfect mobility is introduced in the capital market as standard in GTAP-AGR, based on a CET function, and in none of the models imperfect mobility is standard in the labour market. Nevertheless, there are some studies including imperfect mobility in the labour market: Ivanchovichina and Martin (2004) as well as Zhai and Wang (2002) study possible effects of China's accession to the WTO, taking into account barriers to labour mobility between rural and urban regions with a CET function. Both studies conclude that labour market reforms, mainly lifting the barrier for rural-urban migration, would significantly improve efficiency and equality. Intersectoral labour migration – between agricultural and non-agricultural sectors – is considered in a study of Valenzuela *et al.* (2008), which evaluates the sensitivity of results of global trade liberalisation to different assumptions on factor mobility, closures and trade elasticities with the GTAP model. The increase in agricultural value added is found twice as high in the specification with perfect labour mobility, compared to immobile labour, which highlights the importance of the mobility assumption. Given the characteristics of a CET function, this approach implies a reallocation of labour in some

[21] This is valid for the case without unemployment. When there is unemployment, factor demand can source additional workers from the unemployed and release workers into unemployment.

[22] For a more detailed review please see section III.2.

form of efficiency unit, which raises the question of determining the units that define the market clearing conditions for labour. Ideally, labour should be defined in ‘natural’/physical units, in order to be able to track the actual quantity of workers who move between sectors.

In order to model imperfect inter-sectoral labour reallocation and to be able to track the physical units, a migration function is introduced in article 2 on *‘Factor Mobility and Heterogeneous Labour’*, where workers migrate between different sector blocks of production. A migration function is also used to depict migration between countries or regions by McDonald and Thierfelder (2009). Migration between rural and urban regions can also be comprehended as migration between agricultural and other sectors. Article 2 (section III) extends the migration function, by deviating fully from the local definition and defining migration bilaterally between different sector blocks of the economy. In the migration function of McDonald and Thierfelder (2009), the migration decision is based on the relative wage of the own region, relative to the average wage level in all regions, with workers migrating to a pool and from that pool. In contrast, the origin of a migrating worker is traceable in the version of the migration function developed for this thesis.[23]

In a first step, labour types, differentiated amongst others by skill categories and ethnicity in the data base, are allocated to segmented sector blocks, which are defined as groups of sectors, e.g., ‘Agricultural sectors’, within which labour is perfectly mobile. Migration is possible between the sector blocks, but only within a specific labour type, e.g. ‘Skilled Arab’. In a second step, migration between these labour types is introduced: Migration depends on the change in the relative wage: the wage a worker could earn in his old sector, compared to the wage he could earn in another sector he could migrate to. Thus, the amount of workers, who migrate from one sector block to another, is determined by the change in the relative wage and labour supply in the base situation. The responsiveness of migration to wage changes is determined by the migration elasticity: If the elasticity is high, labour is mobile between the sector blocks, if it is zero, there is no migration. Migration can naturally be set up between characteristics of other dimensions, too. Workers could migrate/transform to higher skill levels or transform into higher age classes in a dynamic model.

V.3. Productivity Effects from Labour Reallocation

Data reports huge variations between wage rates among different skill classes and sectors. In perfectly competitive markets, only heterogeneous productivities can explain the existence of wage differences (Bourguignon and Bussolo, 2013). When labour moves from less to more productive sectors in CGE models, it is typically assumed to adapt the productivity in the destination sector and an economy experiences a *de facto* increase in labour endowment. Poirson (2001) estimates the impact of labour reallocation on economic growth rates and asks the question, to what extend these reallocation effects contribute to faster or slower growth rates, by using panel data for 65 countries between the years 1960 to 1990. Her findings confirm the importance of labour reallocation effects in determining economic growth rates: countries, which allocate labour relatively more in sectors with a higher productivity, over time grow faster. In addition, Poirson shows that missing

[23] For a detailed description of the migration function see section C.2. of the Appendix.

reallocation, from agriculture to industry and services, accounts fully for the growth gap of African countries relative to other countries.

This raises the question, in how far it is possible for a worker to move between different sectors and adapt the new sector's productivity. Empirical literature on costs of factor reallocation highlights the existence of severe costs of reallocation, mainly caused by non-transferability of skills and losses in skills, which hinders mobility between sectors.

To be able to analyse the productivity effects of labour reallocation, a feature is introduced which allows finally for the following setups:

- Reallocated labour adopts the new sector's productivity.
- Reallocated labour retains the old sector's productivity. Thus, the average productivity of each labour type in each sector block will change.
- Reallocated labour retains the old sector's productivity adjusted for a predetermined productivity change.
- Reallocated labour adopts a productivity somewhere between that of the old and new sectors. Again, the average productivity of each labour type in each sector block will change. For this purpose, productivity is set partly sector and partly factor specific in model calibration.[24]

For this purpose, the Israeli labour market is assumed competitive, hence wage differences reflect differences in factor productivity[25]. Productivity varies between labour types as well as inside a labour type. Wages are defined per productivity unit and thus are equal. Real factors are transformed into productivity units by multiplication with a sector specific efficiency factor. When allowing for migration between sectors, workers are usually assumed to gain the new sector's productivity. To allow for a scenario in which workers maintain their old productivity level, or a share dependent on it, productivity, which typically is sector specific, is made factor specific. If the productivity is factor specific, the average productivity of his new sector adjusts accordingly[26].

[24] This option is possible to model with the approach developed, but not applied in the studies forming this thesis because of data availability.

[25] This assumption of competitive markets implies, that also wage differences within others than the sectoral dimension reflect productivity differences. This is clearly a problematic assumption as there is clear evidence that there are market imperfections existing in the Israeli labour market. As indicated above, e.g., differences between Jewish and non-Jewish workers might accrue from service in the Israeli army, and foreign workers face different rights and negotiation power compared to domestic workers. However, as migration is only possible in the sectoral dimension, wage differences between other dimensions can still be interpreted to originate from market imperfections.

[26] For more detail on the technical implementation of factor specific productivity please see section III.3.2 and Appendix C.3

Additionally, there is an adjustment parameter which allows for variation in the skill transfer. If the adjustment parameter is set to a value less than 1, the worker cannot maintain his former level of income. When it equals 1, the worker maintains his old productivity; if it is greater than 1, productivity increases. This parameter is used to introduce costs of reallocation, which are analysed in article 3 (section IV) on *'Labour Market Flexibility and Costs of Adjustment'*.

V.4. Reallocation Costs

Several empirical studies show, that workers who change sectors can experience large and persistent losses in wages (e.g., Jacobson *et al.*, 1993, Figura and Wascher, 2010 and Fallick, 1996)[27]. Despite differences in methods of assessing the level of wage losses for workers who switch industries, all studies find considerable differences for wage losses between reemployment in the old industry and reemployment in a new industry, which differ from 21% (Figura and Wascher, 2010) to 38% (Jacobson *et al.*, 1993). These earning losses are persistent: According to Jacobson *et al.* (1993), after 5 years, losses still amount to 25% of pre-displacement earnings (see also Fallick, 1996, and Figura and Wascher, 2010). Furthermore, wage losses are depending only little on age and gender and are not only related to few sectors. Local labour market conditions are crucial: losses are larger, when workers are displaced in regions with depressed rates of employment growth. The difference between strong and weak labour markets accounts for one third of the average loss (Jacobson, 1993). Cyclical conditions have substantial and long lasting effects, too, but even workers displaced in a strong labour market are found to experience large wage losses.

The main reason for wage losses is firm- or sector-specific human capital. Fallick (1996) and Jacobson *et al.* (1993) mention in addition wage losses after reemployment originating from especially suited skills, because of particular good matches from intensive search. Other reasons are the loss of wage premiums and the loss of seniority, more specifically lower long term earnings regarding the career, when starting with a lower wage in expectation of a higher wage in the future. In an empirical study on inter-industry mobility of Jewish immigrants in Israel, Darvish (1990) identifies four variables, which are relevant for imperfect labour mobility between industries. First, age is correlated with lower inter-industry mobility. Second, according to the human capital theory of Becker (1962), the worker's level of education serves as approximation of the skill-level: the higher industry specific skills are, the higher is the worker's value for the employer and the cost of inter-industry mobility. Third, the mobility depends on the status at work: (former) self-employed are more reluctant to change industries than employees, because of higher skills, assuming that people deciding for self-employment are particular competent. Fourth, in addition to sector specific skills, labour mobility depends on the settlement region: settlement in economic active areas is negatively correlated with the inter-industry mobility rate. This is because of the higher number of economic opportunities as well as because of the higher availability of information and therefore more intensive search, which increases the probability of finding a job in the old industry.

A study of Garcia-Cebro and Varela-Santamaria (2011) on imperfect intersectoral labour mobility and monetary shocks in a small open economy includes the costs of labour reallocation in a new open

[27] Section IV.2 reviews the literature in detail.

economy macroeconomics (NOEM) model framework. The study includes the cost of reallocation and leisure in the household utility function. Simulating a monetary expansion in a small open economy, Garcia-Cebro and Varela-Santamaria find in the short term less expansionary effects on traded output and less contractionary effects in the long term as well as lower welfare gains or larger welfare losses in the long run, when reallocation costs are included. Tapp (2011) estimates the costs of sectoral labour adjustment for Canada in 2002-2006 with an equilibrium search and matching model and finds adjustments costs up to 3% of output during the first three years. Non-transferability of skills was the predominant contributor to these aggregate costs, which generally remained up to five years. The existence of labour reallocation costs is crucial, when estimating the adjustment of economies to globalization and trade liberalization. Davidson and Matusz (2000) ask, why public and economic opinions are so strongly divided on the issue of whether there are welfare gains from trade liberalisation. The authors reason, that this difference can be explained by deviant views on the labour market: while economists assume a fully-employed and perfectly mobile labour market, the reality of unemployment and other adjustment costs is most apparent to the public.

Despite the empirical evidence for their existence, labour reallocation costs are rarely studied in CGE-models. Chan *et al.* (2005) consider adjustment costs in labour markets in a standard, static CGE-study for Vietnam. They differentiate four different possibilities of treating adjustment cost: firstly, labour moves fully mobile across all sectors; secondly, two blocks are differentiated, agriculture and manufacturing, where there is no mobility between these blocks, but workers are mobile inside a block; thirdly, the same as before, but there are transaction costs when moving within sector blocks; and lastly, mobility between the blocks is possible only with transaction costs. Imperfect labour movement is implemented with a constant elasticity of transformation (CET) function, and transaction costs are implemented as 10% relocation cost on the value of labour movement, assuming a *de facto* reduction in factor endowment. Findings of Chan *et al.* (2005) suggest, that the amount of labour movement between sectors is typically overestimated and that distributional impacts are mostly intensified by transaction costs. Article 3 on *'Labour Market Flexibility and Costs of Adjustment'* analyses, how the existence of labour reallocation costs for movement between sectors is influencing model outcomes.

V.5. General Conclusions

V.5.1. Study Results

The first article on *'Relaxing Israeli Restrictions on Palestinian Labour: Who Benefits?',* presented in this thesis in section II, examines the potential effects of a partial liberalization of labour market policy in Israel with respect to cross-border workers from the West Bank. The study simulates an increase in the number of Palestinians working in Israel from 50 thousand to the pre-Intifada level of more than 100 thousand. The study is based on a detailed depiction of the labour market and factor demand is set up with a series of nested CES-functions.

An opening of the Israeli labour market to more Palestinian workers would increase domestic production, and potentially enhance economic growth in Israel. Opening the labour market would widen the income gap between poor and rich households in Israel by increasing the factor income of rich household groups more than those of some poorer household groups. However, the negative distributional effects of changes in factor incomes will be partially offset by greater reductions in the cost of living for poorer households. Overall there are welfare gains for all household groups in Israel.

These results are robust across a wide range of substitution elasticities. Two elasticities are influencing the results especially strong: the substitution elasticities between Israeli and non-Israeli unskilled workers, and between Palestinian and foreign workers. These are the elasticities of the nested tree, which are closest to the shock (the increase of Palestinian workers). When increasing the substitution elasticity between Palestinian and foreign workers, the effects on the labour market are stronger. Mainly the closest substitutes to Palestinians, the foreign workers, are more negatively affected: Palestinians wages fall less, while foreigners experience a greater decline in wages, the wage rate for aggregate labour decreases slightly. Differences in the effects on Israeli households are not large, while the effects on the macroeconomic level are very small, but positive, as the elasticity is increased. Increasing the substitution elasticity between Israeli and non-Israeli unskilled workers increases the negative impacts on poor Israelis: factor income decreases for unskilled workers.

Households in the West Bank would benefit from sharply increased remittances from Palestinians working in Israel. Such additional inflows to the West Bank from employment abroad, in combination with the outflow of workers, could, however, negatively impact on the West Bank's economy. While previous studies have found a positive effect from the transfer of high labour income from Palestinian cross-border workers to the West Bank, the interactions effects are not well articulated. There is therefore a case for multi region CGE model for the West Bank and Israel that endogenises the Palestinian labour supply decisions and the consequent indirect effects upon the West Bank.

The third article on *'Intersectoral Factor Movements: Do Adjustment Costs Matter for Welfare?'* in section IV quantifies the relevance of transaction costs from labour reallocation at an economy wide level. The study applies a variation of the labour market scenario from the first article to three different setups of labour mobility: migration without cost, with 20% costs and with almost prohibitive costs.

Labour reallocation has two different effects: first, the moving worker typically adopts the new sector's productivity, which influences *de facto* factor endowment of the economy and thus affects simulation results. Second, there are transaction costs of labour reallocation. In order to disentangle productivity effects from the transaction costs, migrating workers are assumed to keep the level of productivity of their sector of origin, which eliminates the productivity effect[28]. Thus, the average sectoral productivity of each labour type will change in case of sectoral in-migration. The three labour market setups are: First with 'No costs', a high migration elasticity allows for strong labour reallocation after changes in relative wages. Second with '20% costs' reallocated workers experience a 20% cut in productivity. Productivity is fully factor specific and reallocated workers' wages as well as productivity decline by 20% compared to their former earnings/productivity. Third, with 'High costs', reallocation costs are high enough to fully prevent labour reallocation. Hence, labour migration is completely inelastic.

[28] The productivity effect is analysed in article 2, section III.

The scenario applied is similar to the one in article 1 but with a stronger shock: Palestinian employment increases in Israel by 370% to a historic level from 2000, when 26% of all Palestinian employees were working in Israel. Similar to article 1, increased labour supply induces economic growth and increases welfare for all households in Israel, though income effects are stronger for rich households.

Results from the different mobility setups show that labour reallocation costs matter, especially for the analysis of distributional effects. Increasing transaction costs decrease positive effects accruing from the liberalisation of the Israeli labour market for Palestinians. This is reflected in lower economic growth, affecting nearly all sectors of the economy. The scenario employed causes labour reallocation between sector blocks. Increasing reallocation costs lowers the ability of workers to adjust to shocks in the labour market, which results in increased wage effects and thus income effects. Especially workers, which otherwise would move out of a sector, are negatively affected. In this study, these are employees in agriculture and construction, sectors were wages are below average. Thus, taking into account factor reallocation costs further increases the gap between rich and poor households in the economy and reduces positive growth effects to the Israeli economy.

Neglecting factor reallocation costs and factor specific productivity in CGE-modelling might overestimate the size of potential adjustments in the labour market as a response to exogenous shocks and thus affect simulation results. Article 2 on '*Factor Mobility and Heterogeneous Labour*', presented in section III of this thesis, aims to estimate size and relevance of productivity effects from factor reallocation. For this purpose, two scenarios of world market price changes are run: the first causing labour moving from agriculture to manufacturing and thus simulating labour migration to sectors with higher labour productivity, resulting in increasing total factor productivity. The second scenario causes migration from manufacturing to agriculture, leading thus to decreasing total factor productivity. Both scenarios are run two times: first, labour adopts the destination sector's productivity and thus average sectoral labour productivity changes. Second, labour keeps the productivity from its sector of origin and thus average sectoral labour productivity is not directly affected by migration.

In the first scenario, which simulates a productivity increasing allocation, the GDP effect is 138% smaller, when excluding the productivity effect and productivity is held constant. This means that the GDP growth of 0.43% becomes a decline of -0.17%, when the productivity effect is excluded. All agents of the economy benefit from the increase in productivity if productivity is modelled sector specific. When the productivity effect falls away, households and the government experience clear losses. Adjustment effects, which lead to a lower total factor productivity, i.e., movement into agriculture, are simulated in the second scenario. The losses connected with this factor reallocation are quantified by comparing the first run, with sector specific labour productivity, to the second run, when productivity is factor specific and thus held constant for the economy as a whole. GDP is 0.33 percentage points higher, when labour productivity is assumed sector specific. All household groups are less negatively affected, when assuming factor specific productivity, the poor are even positively affected.

The results show the importance of productivity effects from factor reallocation for model outcomes. This is valid in case of imperfect labour mobility and becomes more relevant with higher migration elasticities, such as modelled in this paper, as well as with perfect labour mobility, which would result in even stronger productivity effects due to the stronger reallocation of labour. The size of the productivity effect depends on the extent and the direction of labour reallocation, as well as on the sectoral differences in productivity.

Both setups, fully sector specific productivity and fully factor specific productivity, are extremes. The study uses these extremes to show the relevance of the labour market specification for simulation results. For a realistic depiction of the labour market, it is likely that the specification should be somewhere in between the extremes and would depend, besides others, on who migrates first, which part of the productivity is sector specific and the time horizon. The productivity setup should be more factor specific in the short run and in the long run, when workers are adapting to their new tasks, productivity becomes more sector specific. Regarding the question on who migrates first, one might argue that the best workers are the first to migrate, because they have the highest capacity to adapt to a new labour type (e.g. a higher skill level or sector to work). Then migration should decrease productivity in the old sector of work and affect positively the destination labour type. On the other hand, a firm which decreases employment first might release the least productive workers or those workers choose to change their situation, which are least appropriate for the job. With this assumption, migration should increase productivity in the old sector of employment and negatively influence the destination factor type. Which effect dominates depends on the specific situation. As long as no empirical evidence exists, the model is based on the assumption that migrants move with average and not marginal productivity.

V.5.2. Final Comments and Outlook

This thesis develops a comprehensive framework to model imperfect labour mobility in CGE models. First, the article on *'Relaxing Israeli Restrictions on Labour: Who Benefits?'* introduces a single country CGE model for Israel with a detailed labour market and a nested CES production process. Based on this model, the second article on '*Factor Mobility and Heterogeneous Labour'* introduces imperfect mobility between sectors with a migration function. It furthermore develops the possibility to change between sector and factor specific productivity, which is used to estimate productivity effects from factor reallocation. This theoretical approach is applied in the third article on '*Labour Market Flexibility and Costs of Adjustment',* to analyse the macroeconomic costs of intersectoral labour reallocation found in several empirical studies.

A nested factor demand is found useful to depict heterogeneity of factors. A main critic with this approach is the non-availability of required additional parameters, thus, substitution elasticities are mostly rather guessed instead of empirically estimated. However, careful sensitivity analyses show robust results for a wide range of elasticity values. The value of a substitution elasticity is affecting the results strongly only for extreme values or in combination with factor specific productivity, when productivity differences are huge, but this is more a matter of the productivity setup. Stronger than the actual value of the elasticity, the actual nesting structure and nesting hierarchy seem to matter for model outcomes. In this field, too, modelling conventions are not based on empirical studies. In summary, while the nested CES structure for factor demand helps to depict the labour market structure of a country, additional research is needed in the estimation of substitution elasticities and how and according to which factors the nesting structure should be determined.

Productivity effects from labour reallocation are an important driver for model outcomes. The productivity effects are larger, the stronger the change in relative wages, the higher the mobility of labour, and the stronger the differences in sectoral productivities. The relevance of productivity effects for model outcomes indicate that the assumption of full mobility might overestimate positive macroeconomic effects accruing, e.g., from trade liberalisation. The aim of the study is to show the relevance of productivity effects, not to depict a realistic situation. In order to be able to set up a realistic scenario, there is need for empirically based data on migration parameters between sectors. Furthermore there is need for additional research on which part of the productivity is factor and which part sector specific.

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A. The Database: A Social Accounting Matrix for Israel[29]

A.1 Introduction

A Social Accounting Matrix (SAM) for Israel and the year 2004, which is developed by the Agricultural and Food Policy Group at the University of Hohenheim, serves as database for the studies forming this dissertation report. A SAM provides a comprehensive description of the economy and, similar to the Input-Output framework and National Accounts transactions, data is displayed in matrix format for a particular year with multiple accounts[30]. Revenue is presented on rows, expenditures in columns and for each account total revenue must equal total expenditures. While the main purpose of Input-Output Tables is to depict the structure of the economy, mainly the relation between industries through transactions and intermediate inputs, the emphasis of a SAM is on distributive aspects. For this purpose, institutional accounts are disaggregated, where the focus and strength of the SAM is less on the disaggregation itself, but on the relation of different institutional units to the production structure and on transfers between these institutional units.

The SAM is developed in a top-down approach: first, a balanced macro SAM with 13 accounts is compiled, based on official Israeli data sources (National Account data and Supply and Use Tables, both from the Israeli Central Bureau of Statistics, ICBS, 2009a and 2009b, respectively). This macro SAM serves as base for a detailed micro SAM with multiple accounts, Table A.3 shows a detailed list of the Micro SAM accounts. The SAM is conducted for 2004, a year with a comparatively stable political situation between Palestine and Israel as well as other neighbouring countries and which can be considered a relatively 'normal year' in terms of its ability to represent an equilibrium state.

Besides the use of the SAM as data base for the studies conducted in the framework of the DFG-project on '*the economic integration of agriculture in Israel and Palestine*', the SAM is also contributed to the GTAP-database and for this purpose transformed to the GTAP Input-Output-Table format.

The following parts of the chapter describe the Micro SAM in detail, with emphasis on the factor and household accounts, which are most relevant for the studies in the main part of this report. The work on this SAM for Israel was a joint work, where my focus of work was on the household account.

A.2 The SAM for Israel

A.2.1 Activities and Commodities, Trade Margins

The Israeli SAM distinguishes 47 activity and commodity accounts: 10 agricultural accounts, 25 industrial accounts, and 12 service accounts (Table A.3). Major sources of industry-related data are the Supply and Use Tables (SUT) of 2004 (ICBS, 2009b).The differentiation between activities and commodities allows for the valuation of output at producer prices and consumption at market prices

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[29] This chapter is mainly based on and partly identical with Siddig *et al.* (2011).
[30] For a detailed description and discussion of SAMs see for example Pyatt (1985), Pyatt(1999) or Keunig and de Ruijter (1988).

(including indirect commodity taxes and transactions costs). In addition, the separation allows for multi-product activities and for the commodity to be produced by more than one activity.

The transition from basic prices to purchaser prices includes expenses for marketing the product and transporting it to the purchaser. These expenses are defined in the supply table as ‘trade and transport margins’ which includes taxes on and subsidies for products. The trade margins appear in the SAM as payments from the commodity account to the margin account. These payments are then channelled through the trade margins account to the commodity account ‘trade services’, while transport margins are payments from transport margins to the commodity account ‘transport and business services’.

A.2.2 Production Factors

Israeli Labour

Two ICBS publications are used as data sources for the domestic labour account: the Labour Force Survey (LFS) of 2004 (ICBS, 2005a) and the Statistical Abstract of Israel 2006 (ICBS, 2006a) which contains data from the Business Survey (BS) of 2004. Data on physical labour force are taken from the LFS, and the BS is used to obtain data on employees’ compensation.

The total number of employed persons is 2.4 million in 2004, including wage employees, family members, persons staying in institutions who work at least 15 hours per week and kibbutzim workers[31]; persons temporary absent from work are also included (ICBS, 2005a). In a first step, total domestic workforce is split according to ethnic groups into Jewish, about 2.1 million employed persons, and Arab, about 274,000 employed persons, representing the two major ethnic groups in Israeli society. For data availability reasons the Arab Israeli group is merged with all other ethnic minorities, which are 71,000 persons. The second step separates the ethnic labour groups into female and male, to be able to account for lower average gross income from work of female workers, which is found to be 37% lower than the income of their male counterparts. Reasons are lower wage-rates for females and less weekly working hours (ICBS, 2006a, Table 12.41). In addition, the number of working women in the Arabs and others group is about 60% smaller than the number of working males, whereas the numbers of female and male employed persons in the Jewish population are found almost equal. Thirdly, the domestic workforce is disaggregated into 8 professions with different skill levels: academic professionals, associate professionals and technicians, managers, clerical workers, agents and sales- and service workers, skilled agricultural workers, other skilled workers, and unskilled workers (ICBS, 2005a)[32].

Average wages are used to calculate the total annual compensation of employed persons for each labour account and each sector. Wages are derived from a Business Survey (BS) based on employers’ reports to the National Insurance Institute (ICBS, 2006a, Table 12.38). Different definitions and coverage, sources, methods of data collection, and estimation procedures cause several difficulties in matching the wage data of the BS to the labour force data of the LFS[33]. The BS reports average wages

[31] A kibbutz (‘gathering, clustering’; plural kibbutzim) is a collective community in Israel based on agriculture.
[32] For more details and explanation on the 8 professional groups, see ICBS (2005a).
[33] For details on how these difficulties were treated please see Siddig *et al.* (2011).

differentiated by economic sector of employment. In addition data on wages are available according to gender and profession in Table 12.41 of the BS (ICBS, 2006a); there is no information on wages according to ethnic group. In order to link the available data, a multiplicative factor, differentiated by profession and gender, is used to adjust monthly average wages of each sector according to profession and gender. Finally it is assumed that wages do not differ between Jews and 'Arabs and others' when working in the same sector with the same profession and gender, as no more detailed data is available.

Table A.1. Distribution of Employed Persons and Monthly Wage Rates

	Number of Workers (Thsd.)	Percentage Distribution	Monthly Wage (ILS)
Jewish Female	922	35%	9,258
Jewish Male	1,131	43%	13,713
Arab & Others Female	86	3%	7,596
Arab & Others Male	261	10%	9,609
Palestinians	50	2%	2,277
Foreigners ROW	189	7%	3,916
Total	*2,640*	*100%*	-

Source: based on Siddig *et al.* (2011)

Total monthly compensation is calculated with the average monthly wages and the number of employed persons in each sector received from the LFS, and scaled to the original compensation values, which are calculated without disaggregation according to profession. The annual labour compensation is calculated and balanced to the National Accounts data.

Foreign Workers

In addition to the Israeli workforce the SAM distinguishes two groups of non-Israeli workers: Palestinians, who typically commute to Israel on a daily basis from the West Bank and Gaza[34], and other foreign workers from the rest of the world, mostly coming from Asia to work in Israel. Many foreign workers in Israel work without legal documents, often overstaying tourist visa or illegally crossing the border (ICBS, 2005b). Estimates on the number of illegal foreign workers in Israel vary widely, but even conservative assessments suggest that the number of illegal foreign workers is as high as the number of legal foreign workers (e.g., ICBS, 2005b). Because illegal workers represent a considerable part of the total workforce in several sectors, particularly agriculture and construction, the current SAM reserves two separate accounts: illegal workers from Palestine and illegal workers from the rest of the world.

Data on foreign workers is obtained from the Wages and Employment Monthly Statistics of June, 2005 by the ICBS (2005c), however, information on foreign labour is not published as detailed as for the domestic labour force. Most detailed data on Palestinian workers in Israel is available from the

[34] Actually, due to political tensions, since the outbreak of the second intifada in 2001 the number of Palestinians from Gaza working in Israel dropped by more than 90% and since 2006 the border is fully closed, there are no Palestinians from Gaza working anymore in Israel (Bank of Israel, 2006).

Palestinian LFS (PCBS, 2005). This information is also considered to be more accurate than the data published by the ICBS, as the latter includes workers who receive their wages through the payment department of the Employment Service only, whereas the Palestinian LFS relies on household surveys. 8.7% of the total Palestinian labour force, 578 000 persons, are working in Israel (PCBS, 2005, Table 16f), disaggregated by 6 sectors which are included in the Palestinian LFS. To further disaggregate over the 47 activities of the SAM the distribution inside these 6 sectors is assumed equal to that of the Israeli labour force.

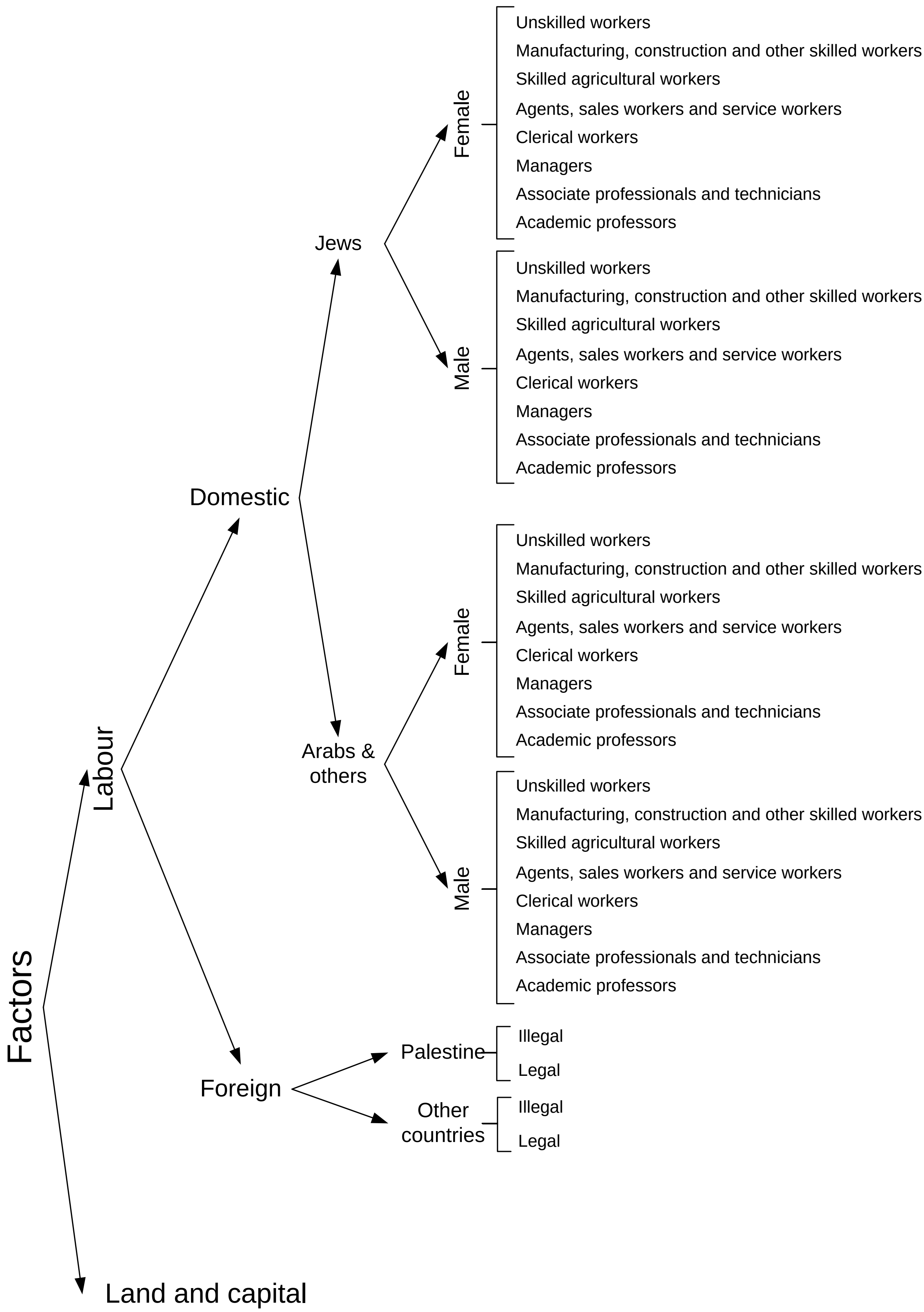
Daily wages and the average number of monthly working days of Palestinian workers in Israel, disaggregated to 6 sectors, (PCBS, 2005, Table 41) are used to calculate average monthly wages. As no more detailed information on wages is available, it is assumed that average wages in all subsectors equal the corresponding wage rate of the 6 main sectors. The number of illegal Palestinian workers in Israel is estimated to be 35,000 in 2004 by the Worker Advice Center (2004). Illegal Palestinian workers are deducted from the total number of Palestinian workers in Israel, 50 286, obtained from the Palestinian LFS, assuming the LFS reports also illegal workers. Thus, about 70% of all Palestinian workers in Israel are undocumented and 30% are legal. The derived number of legal Palestinian workers, 15 286, almost doubles the number published by the ICBS, which considers workers who receive their wages through the payment department of the Employment Service only (ICBS, 2006a, Table 12.34). The total annual labour compensation in the different sectors is split according to the shares of legal and illegal Palestinian workers, making the rough assumption that legal and illegal workers earn the same wage rate.

The most detailed data on foreign workers from the rest of the world (from here on, ‘foreign workers’) in Israel in 2004 is obtained from the Central Bank of Israel (CBI) annual report 2005 (CBI, 2006). The CBI data is based on the national accounts data of the ICBS and includes reported and unreported foreign workers. As data for 2004 are not available (the annual report of the CBI for 2004 does not contain a labour market report), 2004 values are calculated using the values of 2005 and the rates of change over the previous year. Additionally, the number of foreign workers in 10 distinct sectors is obtained by the number of working permits issued in that sector in 2005 and the rate of change over 2004, published both by the CBI (2006: 24). Further disaggregation to the 47 activities of the SAM follows the process chosen for Palestinian workers.

Wages of foreign workers are obtained from ICBS (2005c, Table 1.22), which reports the monthly average wages for workers from abroad in 7 distinct sectors and one wage rate for all ‘other industries’. Housekeepers and homecare workers insured by their employer are excluded from this survey. The following assumptions are made: First, all foreign workers in Israel work for wages and thus are employees. Second, average wages of illegal foreign workers are similar to those of legal foreign workers[35]. Third, housekeepers and homecare workers insured by the employer receive the

[35] Although one might assume that illegal workers receive lower wages, several sources report the contrary (Kav LaOved, 2004; Miaari and Sauer, 2006). However, as there is no specific statistical information available, the same wage rates for legal and illegal workers are assumed in this study.

Figure A.1. Disaggregation of Factor Accounts in the SAM



Source: Siddig *et al.* (2011)

same average monthly wages as foreign workers employed in healthcare services (compare ICBS, 2005c, Table 1.22). Fourth, average wage rates of subsectors are equal within the main sectors and fifth, the average monthly wage rate in all main sectors for which no specific average wage rate is published equals the wage rate in 'other industries'. The total number of foreign workers is estimated to be 188 000 in 2004 (ICBS, 2005b) which is quite close to 188 500, published by the CBI for the same year (CBI, 2006). The ICBS (2005b) also provides data on the number of foreign workers staying in Israel with and without working visas, thus 48.7% are legal and 51.3% are illegal workers, and are assumed equal in all sectors. Finally, the total compensation of non-domestic workers is scaled to the value of compensation of employees paid abroad from the national accounts data (ICBS, 2009a, Table 32), which implies a reduction by 18.3%[36].

Balancing the value of compensation for foreign employees to value of the compensation of employees paid abroad from the national accounts assumes, that workers send their full income abroad and do not consume in Israel; Palestinians, too, are assumed not to consume in Israel. This assumption is surely questionable. Nevertheless, Palestinians from the West Bank use to work in Israel on a daily basis, returning to Palestine for food and lodging, what might support the assumption.

Land

As other economic activities mostly require a very small land area, land is considered a production factor for agricultural activities only. More than 90% of the land is owned by the Israeli state and farmers can lease land on long term contracts, lasting 24 to 99 years, through the Israeli Land Administration (Egoz, 1996). Leasing rates depend on several factors, including the type of usage, area and irrigation facilities. There is no free land market in Israel. The value of land in the specific agricultural activities is derived from the area allocated to agricultural activities and the annual leasing rates. Data on agricultural area are taken from the Statistical Abstract of Israel 2010 (ICBS, 2010) and FAO (FAOSTAT, 2011); the Israeli Ministry of Justice (IMJ, 2010) publishes leasing rates of land in Israel.

Capital

To estimate capital compensation of each activity, a land-capital composite is calculated as residual between labour compensation and net domestic product at basic prices. The total value of net domestic product as well as its distribution over 13 sectors for 2004 is obtained from ICBS (2009a, Table 16), however, the values for different sectors do not sum up to the total due to 'errors and omissions'. The value of errors and omissions is dispersed over the 13 sectors, assuming that the errors and omissions occurred equally in all sectors. Labour compensation is aggregated to the 13 sector aggregation and subtracted from the net domestic product in each sector. The residual value in each of the 13 sectors is assumed to account for land and capital compensation. Finally the land-capital composite is reallocated to the 47 activities of the SAM and the value of land is deducted in agricultural activities. The share of land and capital compensation in the total value added is rather

[36] Given the weak wage data, a scaling of this size might be reasonable. Palestine is officially not regarded as foreign country by Israel, compensation of Palestinian employees is therefore not included in the compensation of employees paid abroad.

low in comparison to other OECD member countries. Also, for the sector 'Imputed value of bank services' the NA state a negative value added. Because labour compensation in this sector is zero, according to the 1995 IOT (ICBS, 2002, Table 3), capital compensation is negative.

A.2.3 Households

Classification

Household data are obtained from the publications of the ICBS: the National Accounts 1995-2007 (ICBS, 2009a), the Expenditure and Income Survey of 2004 (ICBS, 2006b; ICBS 2006c), the SUT 2004 (ICBS, 2009b), the General Government Accounts 2000-2005 (ICBS, 2007), and the Social Survey 2004 (ICBS, 2011). A detailed household account in the SAM is the basis to analyse the livelihoods of people and distributional effects, and gives the opportunity to simulate various discriminatory policies. Households can be classified according to a huge variety of dimensions, e.g., according to income level, ethnic background, head of household, or spatially by state or locality. In the SAM for Israel, the Israeli population is disaggregated into income quintiles in order to differentiate according to living standards. The use of income as only criterion for classifying households according to living standard is controversial because it does not reflect the whole range of aspects which comprise the living standard (Haughton and Khandker, 2009). Nevertheless, income is used here as a proxy for the living standard, because of good data availability from the Income and Expenditure Surveys of the year 2004 (ICBS 2006b, 2006c), which provide detailed information on households classified according to income.

Households are classified to income quintiles by net income per standard person, in order to take into account different household sizes and scale economies, which arise, e.g., from sharing living accommodations and cooking. In addition to income, households are differentiated by ethnicity into Jewish (83.6% of population) and non-Jewish (Arab and others) in Israel, to capture social, behavioural and cultural differences between these groups. The non-Jewish group, which is dominated by the Arab-Israeli population (12.7% of population), includes also immigrants from the former Russian federation who are non-Jewish or people who do not have a Jewish mother and therefore are not considered to be Jewish. The share of non-Jewish non-Arabs is about 3.7% of the total Israeli population. Table A.2 provides an overview of the distribution of Israeli households by income quintiles and population group. The income quintiles are ranged from one, which represents the household group with the lowest average income, to five, which is the quintile with the highest income, for both Jews and 'Arabs and others'. Thus, the SAM includes 10 household groups: total households are first classified according to income and second, each quintile is divided into ethnic groups. As a result, household groups differ substantially in size, with Arabs in the highest income quintile establishing the smallest group (13,000 households) and Jews in the highest income quintile establishing the largest group (377,000 households). The Income Survey (ICBS, 2006b) provides data on deciles according to net income per standard person and data by ethnical group. Data are aggregated to quintiles and allocated according to ethnicity. As there is no information on average income within the published deciles according to ethnic background, it is assumed, that the income levels of different ethnic groups within a similar income quintile are similar.

Table A.2. Israeli Households Classified by Ethnic Groups and Income

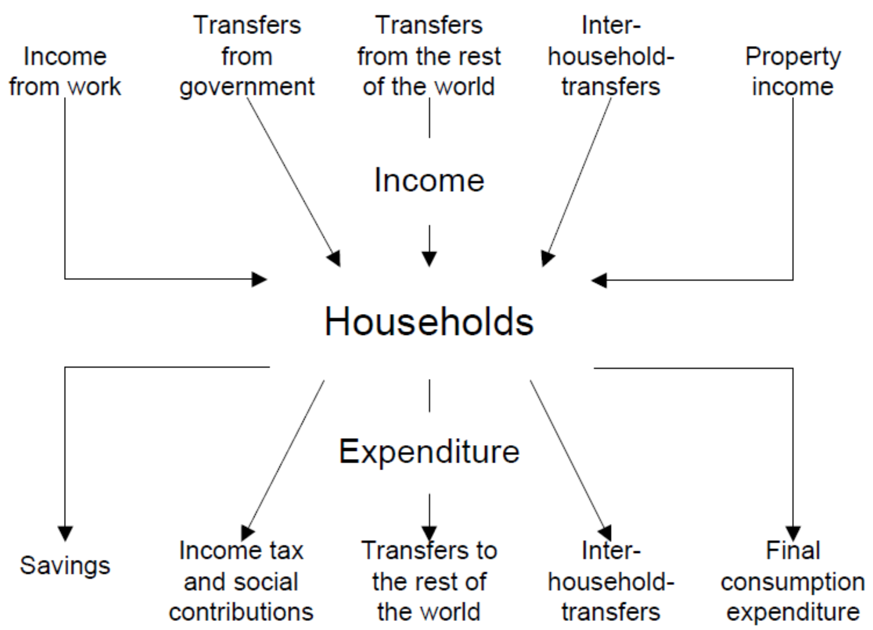
	Jews		Arabs and Others	
Income Quintiles	Number of Households [Thousand]	Percentage Share	Number of Households [Thousand]	Percentage Share
Quintile 1	257.0	65.7%	134.0	34.3%
Quintile 2	299.0	76.6%	91.0	23.4%
Quintile 3	336.0	86.3%	53.0	13.7%
Quintile 4	362.0	92.8%	28.0	7.3%
Quintile 5	377.0	96.6%	13.0	3.4%
Total	*1630.0*	*83.6%*	*320.0*	*16.4%*

Source: ICBS (2006c)

Income

The SAM provides a comprehensive description of transaction flows in which households are involved (Figure A.2). The household earns income from work or other factors of production and receives transfer payments from the government, foreign countries, or other households. Income is spent on final consumption goods and services, taxes, and transfers to other households (domestic and abroad). Savings are balancing total income and total expenditures.

Figure A.2. Monetary Flows to and from Households



Source: Siddig *et al.* (2011)

Labour compensation is the major component in household income and includes, for consistency with the labour account, income from wages and self-employment (employees), as well as imputations of wages for employed persons who are not employees. First, Jewish labour groups are allocated to Jewish household groups and Arab and other labour groups are allocated to their corresponding households. The Social Survey 2004 (ICBS, 2011) provides data on the distribution of different occupations according to the level of total family income, but not according to income quintiles and it does not differentiate between Arabs and Jews. To estimate the number of earners each household group of the SAM holds in each occupation, the income data from the Social Survey are mapped to the household groups, taking into account the number of earners in each household group (ICBS, 2006c, Table 2.2.). Afterwards, the shares each household group holds in the different labour accounts are calculated. These shares are applied to distribute the compensation of labour of each labour group among the different household groups.

There are significant differences in the level of income and its distribution among households when comparing the results of the approach described above, where income from the production side is allocated, with data from the Expenditure Survey (ICBS, 2006c, Table 2.1.). In total, the compensation of labour published in the National Accounts (see the section *production factors*) is 46% higher than the household income from labour published in the Expenditure Survey (ICBS, 2006c, Table 2.1.). The reason might be imputations for employed persons (see above) which are not accounted for in the Expenditure Survey, but which are included in the compensation of labour. In addition, after allocating the labour income to the household groups, the share of income from labour the higher quintiles receive is lower and the share of income from labour the lowest quintiles receive is higher compared to the shares published in the Expenditure Survey. This bias may be caused by the imputations for employed persons, which are assumed to exist primarily in the lower income quintiles.

Household income from capital is obtained from the 2004 Household Expenditure Survey (ICBS, 2006c, Table 2.1). It provides information on monthly capital income for income deciles. The monthly values of property income per income decile are converted in yearly values for the final household groups. Households also receive income from entrepreneurial activities. Every enterprise is finally owned by households or the government; hence, owners receive the profits of their enterprises. Data on transfers from enterprises to households is not available, thus, transfers from enterprises are obtained after deducting transfers to the government, tax payments, as well as enterprise saving from total enterprises income. Transfer payments from enterprises are distributed among the household groups to create a balance between income and expenditure for each household group.

The second source of income to households is transfers from other households in Israel, from the ROW and transfers from the government. On the expenditure side, domestic households also remit abroad, transfer money to other domestic households, and make compulsory payments to the government. Data on inter-households transfers are from the Household Expenditure Survey (ICBS, 2006c, Table 2.1 and Table1.1). The total amount of household transfers as well as the shares of household transfers to the ROW, 60% of total household transfers, is reported by ICBS (2009a, Table 28). Domestic inter-households transfers, the remaining 40%, are distributed among the household groups according to the distribution of total transfers. Data on transfers from the government to households is obtained from the General Government Accounts (ICBS, 2007), while information about its distribution among different household groups is based on the Household Expenditure Survey (ICBS, 2006c). Government transfers to households include social insurance benefits, pensions, and other allowances and assistance. Income from social benefits reported in the Household Expenditure Survey (ICBS, 2006c, Table 2.1) is found to be lower than that reported in the Government Account (ICBS, 2007, Table 5.4). Therefore, the former is scaled to the level of the latter as household income is generally assumed undervalued in household surveys. Data on transfers to households from the ROW is obtained from the National Accounts (ICBS, 2009a, Table 28) and distributed among household groups according to household income from allowances and assistance excluding Israeli institutions, which is obtained from the Household Expenditure Survey (ICBS, 2006c, Table 2.1)[37]. The value of transfer payments of Israeli households to households abroad is distributed among household groups according to the distribution of total transfer spending (ICBS, 2009a, Table 28).

Expenditure

The Household Expenditure Survey of the year 2004 provides detailed information on household monthly consumption expenditures by income quintiles (net income per standard person; ICBS, 2006c, Table 1.1). Based on the ISIC (Revision 3) commodity classification, the detailed expenditure data of the survey is allocated to the 47 commodity classification of the SAM. The yearly consumption expenditures of the whole population according to the Household Expenditure Survey adds up to ILS 234,408 million, while the value published in the National Accounts is 34.7% higher or ILS 315,860 million (ICBS, 2009a, Table 7). Accordingly, the Household Expenditure Survey data is scaled-up to the value of the National Accounts. The scaling-up follows the approach of source unification and increases consistency.

Due to missing data, it is assumed that that the consumption patterns of the different ethnic groups in a specific quintile are equal. In addition to consumption expenditures, households spend money for compulsory payments to the government, including direct income taxes, social insurance payments, and health insurance payments, as well as transfers abroad. Data on these components are provided in the Household Expenditure Survey (ICBS, 2006c, Table 2.1) and the National Accounts (ICBS, 2009a, Table 30). Data from the Household Expenditure Survey are used and scaled-up to the National Accounts level.

The Household Expenditure Survey (ICBS, 2006c, Table 1.1) provides also information on selected savings items. Based on this information, the share of each quintile in total savings is calculated and scaled-up to meet net private savings published in the National Accounts (ICBS, 2009a, Table 29). Savings in the third quintile groups obtained by this approach are found too low, resulting in negative transfers from enterprises. Therefore, savings of household groups of the third quintile are adjusted, reducing slightly the savings of other household groups by an equal rate to keep total household savings constant.

[37] The value of the current transfers from abroad excluding transfers to the Israeli government obtained from the Household Expenditure Survey is lower than that from the National Accounts, as the latter includes transfer payments to Israeli non-profit institutions as well as transfers from immigrants. Accordingly, the Household Expenditure Survey value is scaled-up to the National Accounts level.

A.2.4 Taxes

The SAM identifies four types of major taxes: taxes on domestic production, taxes on imported products, direct taxes including health and social insurances, and taxes on production factors (Table A.3). Major sources of data on taxes and subsidies are the National Accounts 1995-2007 (ICBS, 2009a, Table 30), and the General Government Accounts (ICBS, 2007). The SUT of the year 2004 (ICBS, 2009b) provides data on net taxes and subsidies on products only. Therefore, it could not be used as data source for the different tax accounts included in the SAM. The distribution of the total value for each tax type over the corresponding accounts is based on unpublished data by ICBS and personal communication with ICBS staff. Taxes on production and products include indirect taxes on production, production subsidies, export subsidies, value added taxes on domestic products, fuel tax, excises on tobacco and cement, other taxes on domestic products, and sales subsidies on domestic goods. Taxes on imported products are represented by four accounts: value added taxes on imports; customs; purchases and other taxes on imports; and taxes on defence imports.

Direct taxes and insurances are represented by five different accounts. The allocation of income tax to the enterprises account is straightforward as enterprises are represented by one single account in the SAM. For households, income taxes payments are allocated according to data in the Household Expenditure Survey. Social insurance payments are reported in two separate categories: social insurance payments by employers and social insurance payments by employees. Social insurance payments by employers are levied on production activities based on the value of labour compensations by each activity. The payments are merged into the activities payments to labour. Therefore, labour compensations received by production factors from activities include social insurance payments by employers. On the other hand, social insurance payments by employees are levied on income of production factors prior to allocations to households. At this point, production factors pay total social insurance payments by employers, which are already received from activities, as well as the social insurance payments by employees to the corresponding tax account. Again, the distribution of the entire payments is based on labour income. Health care in Israel is both universal and compulsory and is administered by a small number of organisations which are government funded. All Israeli citizens are entitled to the same uniform benefits package, regardless of which organisation they are a member of, and treatment under this package is funded for all citizens regardless of their financial means (IMFA, 2010). In the current SAM, the total health insurance payments reported in the National Accounts (ICBS, 2009a, Table 30) is distributed among the ten household accounts based on the Household and Expenditure Survey.

The remaining tax accounts are taxes on factors of production including land, capital and labour. Taxes on capital and land are merged together under the name 'taxes on capital including land and fixed assets', which is payable by activities based on shares of capital and land use. The labour tax account is disaggregated into 36 labour categories and total wage bill and payroll taxes are distributed over the activity accounts based on the values they pay for the compensation of labour.

A.2.5 Enterprises

Data on enterprises income and expenditure is obtained from the ICBS including the Statistical Abstract 2005 (ICBS, 2005d, Table 14.12) and the National Accounts (ICBS, 2009a). Returns to capital are allocated to enterprises and are ultimately distributed among the enterprises expenditure destinations such as government, households, and the ROW. These returns to capital are calculated as residuals of net domestic product at basic prices after a deduction of the compensation of labour and land. In addition to income from capital, the Israeli government provides enterprises with non-recurrent grants to investors amounting to ILS 8.1 billion in 2004 (ICBS, 2005d, Table 14.12). Enterprise income is spent on paying direct income taxes, transfers to the government in terms of returns to state owned enterprises, transfers to households, transfers to the ROW, and savings.

A.3 Balancing

The SAM is constructed with the top-down approach: first, an aggregated macro SAM with 13x13 accounts is built based on official Israeli sources of data. The macro SAM is balanced based on the T-accounts of the major economic actors in Israel including the government, non-governmental institutions, saving-investment and the ROW. Tax accounts are automatically balanced within the T-account of the government. Small imbalances in the activity and commodity accounts are balanced based on the cells that are sourced from the SUT. These are intermediate consumption, which is reduced by 0.65% and domestic output, which is increased by 0.65%.

The aggregated accounts of the micro SAM are governed by the control totals of the macro SAM and thus are balanced, too. Activities and commodities show various imbalances at the individual accounts level with the summation of the imbalances of all commodities and all activities equalizing zero. Where possible, imbalances were solved manually for obvious incorrect data entries, e.g., intermediate consumption of sugar while there is no domestic sugar production. These errors mainly occur from the mapping and reallocation process between different data sets. Significant improvements are obtained from balancing based on changing what is called the 'weakest link', which corresponds in this context to those SAM cells in which data sources are least trustworthy or data are calculated as residuals.

For final balancing, the cross entropy-method is applied. Although the final automated balancing causes about 40% of the entries to change by more than 10%, these changes occur mainly in small accounts. Less than 5% of the entries with an absolute value higher than 100 million NIS change by more than 10% and only 58 entries (1%) change by more than 25%.

Table A.3. List of SAM Accounts

No.	Commodities and Activities (c, a)
1	Wheat
2	Cereals
3	Other crops
4	Milk
5	Bovine cattle, sheep, goats, and horses
6	Other animal farming
7	Fruits and vegetables
8	Fishing
9	Forestry
10	Gardening, mixed and unclassified farming
11	Coal, oil, and gas
12	Minerals nec
13	Meat products nec
14	Processing of fruit, vegetables and fish
15	Manufacture of edible oils, margarine a. oil products
16	Dairy Products
17	Manufacture of grain-mill products
18	Other food products
19	Sugar manufacturing
20	Beverages and tobacco manufacturing
21	Textiles
22	Wearing apparel
23	Leather products
24	Wood products
25	Paper products and publishing
26	Petroleum and coal products
27	Chemical, rubber, and plastic products
28	Mineral non-metallic products
29	Basic metal
30	Metal products (excl. machinery and equipment)
31	Motor vehicles and parts
32	Transport equipment nec
33	Electronic equipment
34	Machinery and equipment nec
35	Manufactures nec
36	Electricity
37	Water
38	Construction
39	Trade services
40	Transport and business services nec.
41	Water transport
42	Air transport
43	Communication
44	Financial serv. and insurance incl. imputed bank serv.
45	Public Administration, Defence, Education, Health
46	Recreational and other services
47	Dwellings

No.	Factors (f)
1	Jewish female unskilled workers
2	Jewish female industrial skilled workers
3	Jewish female agricultural skilled workers
4	Jewish female sales and service workers
5	Jewish female clerical workers
6	Jewish female managers
7	Jewish female associate professionals and technicians
8	Jewish female academic professionals
9	Jewish male unskilled workers
10	Jewish male industrial skilled workers

No.	Factors (f) – contd.
11	Jewish male agricultural skilled workers
12	Jewish male sales and service workers
13	Jewish male clerical workers
14	Jewish male managers
15	Jewish male associate professionals and technicians
16	Jewish male academic professionals
17	Arab & others female unskilled workers
18	Arab & others female industrial skilled workers
19	Arab & others female agricultural skilled workers
20	Arab & others female sales and service workers
21	Arab & others female clerical workers
22	Arab & others female managers
23	Arab & others female associate professionals and technicians
24	Arab & others female academic professionals
25	Arab & others male unskilled workers
26	Arab & others male industrial skilled workers
27	Arab & others male agricultural skilled workers
28	Arab & others male sales and service workers
29	Arab & others male clerical workers
30	Arab & others male managers
31	Arab & others male associate professionals and technicians
32	Arab & others male academic professionals
33	Foreign workers from Palestine - legal
34	Foreign workers from Palestine - illegal
35	Foreign workers from the Rest of the World – legal
36	Foreign workers from the Rest of the World – illegal
37	Capital including land, and fixed assets
38	Land

No.	Taxes (gt)
1	Taxes on Jewish female unskilled workers
2	Taxes on Jewish female industrial skilled workers
3	Taxes on Jewish female agricultural skilled workers
4	Taxes on Jewish female sales and service workers
5	Taxes on Jewish female clerical workers
6	Taxes on Jewish female managers
7	Taxes on Jewish female associate professionals, technicians
8	Taxes on Jewish female academic professionals
9	Taxes on Jewish male unskilled workers
10	Taxes on Jewish male industrial skilled workers
11	Taxes on Jewish male agricultural skilled workers
12	Taxes on Jewish male sales and service workers
13	Taxes on Jewish male clerical workers
14	Taxes on Jewish male managers
15	Taxes on Jewish male associate professionals and technicians
16	Taxes on Jewish male academic professionals
17	Taxes on Arab & others female unskilled workers
18	Taxes on Arab & others female industrial skilled workers
19	Taxes on Arab & others female agricultural skilled workers
20	Taxes on Arab & others female sales and service workers
21	Taxes on Arab & others female clerical workers
22	Taxes on Arab & others female managers
23	Taxes on Arab & others female assoc. professionals, techn.
24	Taxes on Arab & others female academic professionals
25	Taxes on Arab & others male unskilled workers
26	Taxes on Arab & others male industrial skilled workers
27	Taxes on Arab & others male agricultural skilled workers
28	Taxes on Arab & others male sales and service workers
29	Taxes on Arab & others male clerical workers

No.	Taxes (gt) – contd.
30	Taxes on Arab & others male managers
31	Taxes on Arab & others male associate profes.,technic
32	Taxes on Arab & others male academic professionals
33	Taxes on Foreign workers from Palestine - Legal
34	Taxes on Foreign workers from Palestine - illegal
35	Taxes on Foreign workers from Rest of World - Legal
36	Taxes on Foreign workers from Rest of World - illegal
37	Taxes on capital
38	Production taxes
39	Production subsidies
40	Exports subsidies
41	Value added taxes on domestic products
42	Fuel tax
43	Excises on tobacco and cement
44	Other purchase, excise duties, consumption taxes on domestic products
41	Sales subsidies to domestic goods
42	Value added taxes on imports
43	Import customs
44	Purchase and other taxes on imports
45	Defence imports tax
46	Direct income taxes on Households
47	Direct income taxes on Enterprises
48	Social insurance payments by employees

No.	Taxes (gt) – contd.
49	Social insurance payments by employers
50	Health Insurance Payments

No.	Households (h)
1	Jewish households in first income quintile
2	Arab and other households in first income quintile
3	Jewish households in second income quintile
4	Arab and other households in second income quintile
5	Jewish households in third income quintile
6	Arab and other households in third income quintile
7	Jewish households in fourth income quintile
8	Arab and other households in fourth income quintile
9	Jewish households in fifth income quintile
10	Arab and other households in fifth income quintile

No.	Other Accounts
1	Trade margins
2	Transport margins
3	Government
4	Enterprises (e)
5	Savings – investments
6	Stock Changes
7	Rest of World

A.4 Aggregation for Model Use

For modelling reasons, the accounts of the SAM used in the model work have been slightly adjusted:

Activities and Commodities:

- ‘Forestry’, ‘Transport equipment nec’ and ‘Financial services and insurance including imputed bank services and general expenses’ show negative capital use in production. The sectors are merged with related sectors.
- ‘Sugar’: There is no domestic sugar production; sugar is added to ‘other food’.

Taxes are mapped to the tax accounts used in the model as displayed in Table A.4. Factor use taxes are indexed over factors (TF(ff,a)), therefore each factor use tax account of the SAM, which is specific to a single factor (ff), has one corresponding tax rate in the model. Other tax rates are aggregates of tax accounts in the SAM.

Table A.4. Mapping between Tax Accounts in the Model and Tax Accounts in the SAM

Tax Accounts in the Model		Tax Accounts in the SAM
TM(c)	Tariff rate on commodity c	Import customs
		Defence imports tax
TE(c)	Export subsidy rate	Exports subsidies
TS(c)	Sales tax rates	Value added taxes on domestic products
		Fuel tax
		Other purchase, excise duties, consumption taxes on dom. Products
		Sales subsidies to domestic goods
		Purchase and other taxes on imports
		Value added taxes on imports
TEX(c)	Excise tax rates	Excises on tobacco and cement
TX(a)	Indirect tax rate on activity a	Production taxes
		Production subsidies
TF(ff,a)	Factor use tax rate by factor ff and activity a	Taxes on Jewish female unskilled workers
		Taxes on Jewish female industrial skilled workers
		Taxes on Jewish female agricultural skilled workers
		Taxes on Jewish female sales and service workers
		Taxes on Jewish female clerical workers
		Taxes on Jewish female managers
		Taxes on Jewish female associate professionals and technicians
		Taxes on Jewish female academic professionals
		Taxes on Jewish male unskilled workers
		Taxes on Jewish male industrial skilled workers
		Taxes on Jewish male agricultural skilled workers
		Taxes on Jewish male sales and service workers
		Taxes on Jewish male clerical workers
		Taxes on Jewish male managers
		Taxes on Jewish male associate professionals and technicians
		Taxes on Jewish male academic professionals
		Taxes on Arab & others female unskilled workers
		Taxes on Arab & others female industrial skilled workers
		Taxes on Arab & others female agricultural skilled workers
		Taxes on Arab & others female sales and service workers
		Taxes on Arab & others female clerical workers
		Taxes on Arab & others female managers
		Taxes on Arab & others female associate professionals, technicians
		Taxes on Arab & others female academic professionals
		Taxes on Arab & others male unskilled workers
		Taxes on Arab & others male industrial skilled workers
		Taxes on Arab & others male agricultural skilled workers
		Taxes on Arab & others male sales and service workers
		Taxes on Arab & others male clerical workers
		Taxes on Arab & others male managers
		Taxes on Arab & others male associate professionals, technicians
		Taxes on Arab & others male academic professionals
		Taxes on Foreign workers from Palestine – Legal
		Taxes on Foreign workers from Palestine – illegal
		Taxes on Foreign workers from the Rest of the World – Legal
		Taxes on Foreign workers from the Rest of the World – illegal
		Taxes on capital
TYF(f)	Factor Income tax rate	Social insurance payments by employees
		Social insurance payments by employers
TYH(h)	Direct tax rate on household h	Direct income taxes on Households
		Health Insurance Payments
TYE(e)	Direct tax rate on enterprises	Direct income taxes on Enterprises

B. Base Model Description[38]

B.1 Introduction: General Features of STAGE-LAB

This chapter describes the base model, STAGE-LAB (Version 1), used for the studies in the main part of the thesis. The aim of the chapter is not to describe every single equation but to explain incorporated relationships and the model structure. For a detailed documentation of model equations refer to the model documentations of McDonald and Thierfelder (2009) and McDonald (2007). STAGE-LAB of McDonald and Thierfelder (2009) is developed from STAGE of McDonald (2007) with more details in the factor markets: STAGE-LAB includes a generalised system of nested Constant Elasticity of Substitution (CES) functions in the production process, unemployment and allows for migration between different factor types. STAGE is a single country computable General Equilibrium (CGE) model, using the GAMS (General Algebraic Modelling System) software, and is a direct descendant and development of models from the late 1980s and early 1990s, particularly those models reported by Robinson *et al.* (1990) and Kilkenny (1991).

The model is based on a SAM, which identifies the agents available to the model and serves as database to which the model is calibrated to. For modelling purpose, the data of the SAM is slightly adjusted when the data is read into the model: transactions between an account and itself are set to zero; transfers of domestic institutions with foreign institutions and vice versa are treated as net transfers; transactions between domestic institutions and the government are treated as net transfers. These adjustments change account totals which are finally recalculated. Two additional series of data complete the database: first, quantities of primary inputs used by activity serve to identify real factor quantities and factor prices. Second, a series of elasticities are employed, including substitution elasticities governing the relation between imports or exports and domestic commodities, the CES-substitution elasticities of the production functions, income elasticities of demand and the Frisch (marginal utility of income) parameter for each household.

While agents and transactions are identified by the SAM, the model is defined by behavioural relationships, where a mix of linear and non-linear relationships determines the response to exogenous shocks in simulations. Households are assumed to maximise utility using a Stone-Geary utility function which allows for subsistence consumption expenditures and reduces to a Cobb-Douglas given an appropriate specification of parameters. The households consume sets of composite commodities, which are formed as CES aggregates of imported and domestically produced goods, assuming imperfect substitutability. The optimal composition is determined by relative prices, following the so called Armington assumption (Armington, 1969) of product differentiation by assuming imperfect substitution. This Armington assumption avoids extreme specialisation and price fluctuations which are observable with other trade assumptions, but bears the shortcoming that small numbers stay small and big numbers remain big, what limits the possibility to model structural changes in trade.

Domestic production is depicted by a nested production process. In the first nest, intermediate demand and value added form output with either Leontief or CES technology possible to apply, while

[38] This chapter is mainly based on McDonald and Thierfelder (2009) and McDonald (2007).

CES is set as standard technology. In the second nest, aggregate intermediate demand is formed by intermediates in fixed proportions, using the Leontief technology. Aggregated value added and aggregates of the following nests of the branch are formed using the CES technology, where the optimal input ratio is determined by relative factor prices. The model allows for multi-product activities, assuming a constant proportionate combination of commodity output by each activity. Thus, for any vector of commodities demanded, which is given, there is a unique vector of outputs that must be produced by activities. The vector of commodities demanded consists of domestic demand for domestic products and export demand, assuming imperfect transformability (CET) between domestic and export demand, the optimal distribution is determined by relative prices. Other relationships in the model are generally linear.

The next part of the chapter describes price and quantity transaction relations, with special focus on the labour market, while section B.3 proceeds with the treatment of institutions in the model. Section B.4 describes market clearing conditions and macro-economic closures. A full list of variables, parameters and sets is provided in section B.5. Section B.6 describes the adaption of the model to Israel, especially elasticity values with which the model is set up.

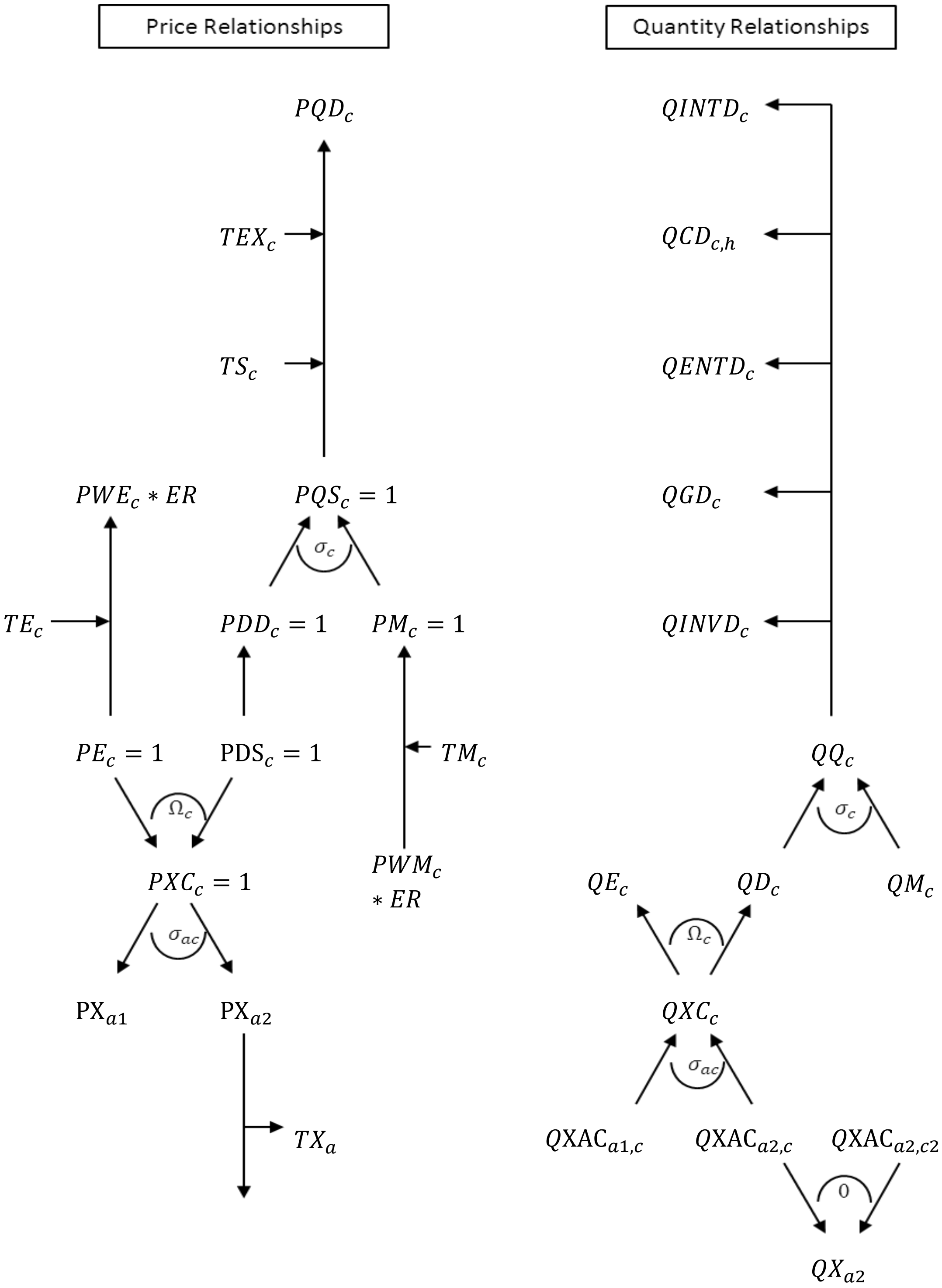
B.2 Price and Quantity Relationships

Trade

An overview over the relations between prices and details on interrelationships of quantities gives Figure B.1. The model contains the assumption of the law of one price, since it is SAM based, thus prices are equal across rows of the SAM. An exception from this rule is made for exports, because the commodity (c) specific export price (PE_c) does not need to equal the purchaser price (PQD_c). However, exports get a separate set in the model and are thus implicitly separate from domestically consumed goods. The differentiation between goods produced for the export market (QE_c) and goods produced for the domestic market (QD_c) is possible because of the Armington assumption of imperfect substitutability between domestic and foreign commodities. Accordingly, an output transformation function (CET) and its connected first order condition are applied, to find the optimal allocation of the domestic output (QXC_c) between the domestic (QD_c) and foreign (QE_c) markets in relation to the optimal export-domestic price ratio (*Equation EX2-EX3*). The model allows for traded and non-traded commodities, as well as domestically produced and non-produced or consumed and non-consumed commodities. If a good is not exported, the quantity produced equals the quantity supplied to the domestic market (*Eq. EX5*). The export price (PE_c), shown on the left of Figure B.1, is determined by the world-market price (PWE_c) and the exchange rate (ER); ad valorem export duties (TE_c) account for the price difference between these two prices (*Eq. EX1*). The country is assumed a small country; world market prices (PWE_c and PWM_c) are fixed. This assumption can be dropped: for this purpose the world market prices are formulated as variables and can become flexible and the model incorporates a downward sloping export demand curve with a constant elasticity export demand function, which is not active, when the world market prices are fixed (*Eq. EX4*).

Imports, on the right branches of Figure B.1, are valued cost insurance and freight (cif) and the import price (PM_c) is determined by the world market price for imports (PWE_c), which typically is fixed, the exchange rate and ad valorem import duties (*Eq. IM1*). Domestic supply (QQ_c) equations are using CES functions and the related first order conditions to determine the optimal allocation of imports (QM_c) and supply from domestic production (QD_c) (*Eq. IM2-IM3*).

Figure B.1. Price and Quantity Relationships for the STAGE Model



Source: McDonald and Thierfelder (2009)

	Equation	Number of Equations and Variables	Variable
	Export Block Equations		
(EX1)	$PE_c = PWE_c * ER * (1 - TE_c) \quad \forall ce$	Ce	PE_c
(EX2)	$QXC_c = at_c * \left(\gamma_c * QE_c^{rhot_c} + (1-\gamma_c) * QD_c^{rhot_c}\right)^{\frac{1}{rhot_c}} \quad \forall ce\ AND\ cd$	C	QD_c
(EX3)	$\frac{QE_c}{QD_c} = \left[\frac{PE_c}{PD_c} * \frac{(1-\gamma_c)}{\gamma_c}\right]^{\frac{1}{(rhot_c - 1)}} \quad \forall ce\ AND\ cd$	C	QE_c
(EX4)	$QE_c = \ econ_c * \left(\frac{PWE_c}{pwse_c}\right)^{-eta_c} \quad \forall ced$	Export demand function when assuming a large country (flexible PWE)	
(EX5)	$QXC_c = QD_c + QE_c \quad \forall (cen\ AND\ cd) OR\ (ce\ AND\ cdn)$	Supply function for non-exported or only exported goods	
	Import Block Equations		
(IM1)	$PM_c = PWM_c * ER * (1 + TM_c) \quad \forall cm$	Cm	PM_c
(IM2)	$QQ_c = ac_c\left(\delta_c QM_c^{-rhoc_c} + (1-\delta_c) QD_c^{-rhoc_c}\right)^{-\frac{1}{rhoc_c}} \quad \forall cm\ AND\ cx$	C	QQ_c
(IM3)	$\frac{QM_c}{QD_c} = \left[\frac{PD_c}{PM_c} * \frac{\delta_c}{(1-\delta_c)}\right]^{\frac{1}{(1+rhoc_c)}} \quad \forall cm\ AND\ cx$	C	QM_c
(IM4)	$QQ_c = QD_c * QM_c \quad \forall (cmn\ AND\ cx) OR\ (cm\ AND\ cxn)$	Supply function for non-imported or only imported goods	

Prices

The supply price of the composite commodity (PQS_c) is the weighted average of the value of domestic supplies and imports (*Eq. P2*). The conditions are derived from the first order condition for the CES-domestic supply equation. Similarly, the price of domestically produced commodities (PXC_c) is calculated as weighted average of the value of goods produced for the export market and goods supplied domestically (*Eq. P3*). Domestic agents consume composite commodities (QQ_c); the purchaser price is determined by the supply price of the composite commodity and ad valorem sales taxes (TS_c) and excise taxes (TEX_c) (*Eq. P1*).

Two price indices can be used for price normalisation, which is needed since the model is homogeneous of degree zero in prices and thus only defines relative prices. The first is the consumer price index (CPI) which is defined as weighted sum of purchaser prices (PQD_c) in the current period (*Eq. N1*). Weights are the shares of each commodity in total demand in the base period. Second, the domestic producer price index (PPI) can be chosen as numéraire. The PPI is defined as weighted sum of supply prices for domestically supplied commodities, where the weights are shares of the value of domestic supply (*Eq. N2*).

	Equation	Number of Equations and Variables	Variable
	Commodity Price Block		
(P1)	$PQD_c = PQS_c * (1 + TS_c + TEX_c)$	c	PQD_c
(P2)	$PQS_c = \dfrac{PD_c * QD_c + PM_c * QM_c}{QQ_c} \quad \forall cd\ OR\ cm$	c	PQS_c
(P3)	$PXC_c = \dfrac{PD_c * QD_c + (PE_c * QE_c)\$ce_c}{QXC_c} \quad \forall cx$	cx	PXC_c
	Numéraire Block		
(N1)	$CPI = \sum_c (comtotsh_c * PQD_c)$	1	CPI
(N2)	$PPI = \sum_c (vddtotsh_c * PD_c)$	1	PPI

Production

The model allows for multiple product activities, thus a commodity can be produced by multiple activities. Domestic production of a commodity (QXC_c) is a CES-aggregate of the commodity produced by several activities ($QXAC_{a,c}$) (*Eq. X1*). It is assumed, that activities produce different commodities in fixed shares, i.e., the output of $QXAC_{a,c}$ is produced in fixed shares as Leontief aggregate of the output of each activity (QX_a) (*Eq. X5*).

	Equation	Number of Equations and Variables	Variable
	Production Block: Commodity Output		
(X1)	$QXC_c = adxc_c * \left[\sum_{a\$\delta_{a,c}^{xc}} \left(\delta_{a,c}^{xc} * QXAC_{a,c}^{-\rho_c^{xc}} \right) \right]^{-1/\rho_c^{xc}} \quad \forall\ cx_c\ AND\ cxac_c$	C	QXC_c
(X2)	$QXC_c = \sum_a QXAC_{a,c} \quad \forall\ cx_c\ AND\ cxacn_c$	Aggregate commodity output without differentiation between producing activities	
(X3)	$PXAC_{a,c} = PXC_c * QXC_c * \left[\sum_{a\$\delta_{a,c}^{xc}} \left(\delta_{a,c}^{xc} * QXAC_{a,c}^{-\rho_c^{xc}} \right) \right]^{-\left(\frac{1+\rho_c^{xc}}{\rho_c^{xc}}\right)} * \delta_{a,c}^{xc} * QXAC_{a,c}^{(-\rho_c^{xc}-1)} \quad \forall\ cxac_c$	(a*c)	$PXAC_{a,c}$
(X4)	$PXAC_{a,c} = PXC_c \quad \forall\ cxacn_c$	Activity commodity price equals commodity price for non-differentiated commodities	
(X5)	$QXAC_{a,c} = ioqxacqx_{\ a,c} * QX_c$	(a*c)	$QXAC_{a,c}$

Output of each activity (a) is formed by a series of nested CES-production functions (Figure B.2), which is mathematically very flexible in form and number of nests. Constraints to the structure are rather economic meaningfulness and data availability, i.e., estimations on substitution elasticities for substitution between and within sub-groups of factors. The base model used incorporates a five level production nest, as displayed schematically in Figure B.2. Activity output is a CES-aggregate of aggregate intermediate inputs ($QINT_a$) and aggregate value added (QVA_a), both in quantity terms (*Eq. X10*). The optimal ratio of aggregated $QINT_a$ and QVA_a is defined by the first order condition for profit maximisation (*Eq. X11*) which is determined by the respective relative prices of aggregated intermediate input ($PINT_a$) and aggregated value added (PVA_a). The aggregate price of intermediates ($PINT_a$; *Eq. X8*) is determined by intermediate input-output coefficients (Figure B.2), where output is the aggregate intermediate input ($QINT_a$).

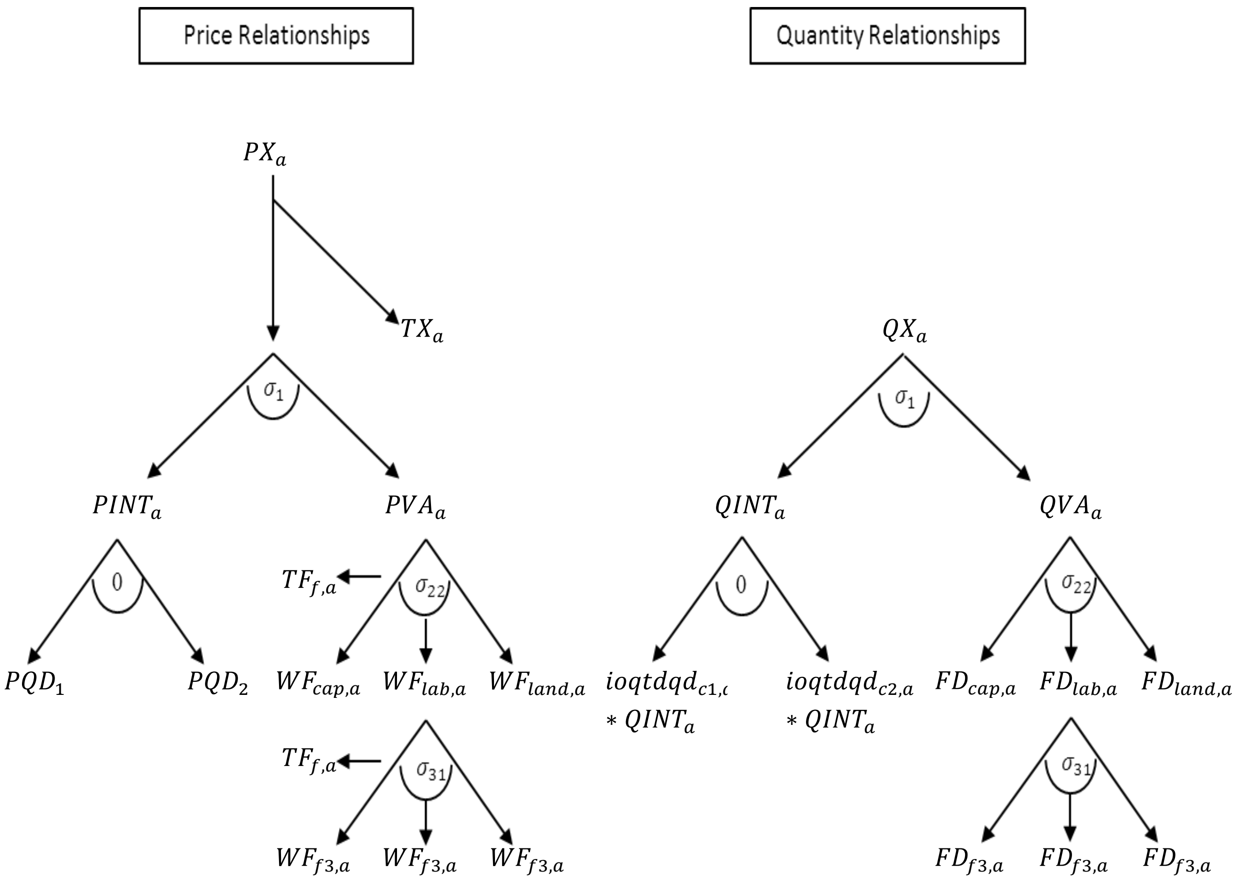
	Equation	Number of Equations and Variables	Variable
	Production Block: Top Level		
(X6)	$PX_a = \sum_c \left(ioqxacqx_{a,c} * PXC_c\right)$	a	PX_a
(X7)	$PX_a * (1 - TX_a) * QX_a = (PVA_a * QVA_a) + (PINT_a * QINT_a)$	a	PVA_a
(X8)	$PINT_a = \sum_c \left(ioqtdqd_{c,a} * PXC_c\right)$	a	$PINT_a$
(X9)	$ADX_a = [(adxb_a + dabadx_a) * ADXADJ] + (DADX * adx01_a)$	a	ADX_a
(X10)	$QX_a = AD_a^x \left[\delta_a^x QVA_a^{-rhoc_a^x} + (1-\delta_a^x) QINT_a^{-rhoc_a^x}\right]^{-\frac{1}{rhoc_a^x}} \quad \forall aqx_a$	a	QX_a
(X11)	$\frac{QVA_a}{QINT_a} = \left[\frac{PINT_a}{PVA_a} * \frac{\delta_a^x}{(1-\delta_a^x)}\right]^{\frac{1}{(1+rhoc_a^x)}} \quad \forall aqx_a$	a	$QINT_a$
(X12)	$QVA_a = ioqvaqx_a * QX_a \quad \forall aqxn_a$	QVA_a with Leontief technology at the top level	
(X13)	$QINT_a = ioqintqx_a * QX_a \quad \forall aqx_a$	$QINT_a$ with Leontief technology at the top level	

On the second level, aggregated intermediate input demand ($QINTD_c$; *Eq. X16*) is a Leontief aggregate. It is a product from fixed input coefficients of intermediate demand of an activity for a commodity. On the second level, too, aggregate value added is formed as multi factor CES aggregate, where primary inputs can be natural factors ($FD_{f,a}$) or aggregate factors ($FD_{fag,a}$), which can itself be formed from natural factors or aggregate factors (*Eq. X14, X17*)[39]. Every factor at the end of a branch of the nesting structure must finally be a natural factor (f), the set (fag) incorporates aggregated

[39] More detail on the nested factor demand equations are provided in section C of the Appendix.

factor types and set (ff) includes natural and aggregate factor types. The first order condition for profit maximisation associated to the CES functions determines the wage rate of factors ($WF_{ff,a}$) in each nest (*Eq. X15, X18*). The wage rate, which is factor but not activity specific in the model because of the law of one price, includes a sector and factor specific weighting factor ($WFDIST_{ff,a}$) to allow for differing wages between activities.

Figure B.2. Production Relationships for the STAGE-LAB Model: Quantities and Prices



Source: McDonald and Thierfelder (2009)

Factors, which are at the same level of a specific nest, are equally substitutable. Thus the nesting structure has the advantage that it allows to differentiate between the substitutability of different factors. In Figure B.2, e.g., different types of labour are assumed to be not equally substitutable. Capital, land and aggregated labour are considered equally substitutable in the production process, where the substitution elasticity (σ_{22}) governs the degree of substitution. Let's assume that labour is differentiated by skill level in 4 labour types, as displayed in Figure C.1 up to the fourth level, thus on the third level skilled labour is formed by two different types of skilled labour and unskilled labour is an aggregate of two types of unskilled labour types. Aggregated skilled and unskilled are equally substitutable, but a specific skilled labour type is not directly substitutable with an unskilled labour type.

	Equation	Number of Equations and Variables	Variable
	Production Block		
	Second Level		
(X14)	$QVA_a = AD_a^{va} * \left[\sum_{f2\$\delta_{f2,a}^{va}} \left(\delta_{f2,a}^{va} * FD_{f2,a}^{-\rho_a^{va}} \right) \right]^{-1/\rho_a^{va}}$	a	QVA_a
(X15)	$WF_{f2} * WFDIST_{f2,a} * \left(1 + TF_{f2,a}\right) = PVA_a * QVA_a * AD_a^{va} \left[\sum_{f2\$\delta_{f2,a}^{va}} \left(\delta_{f2,a}^{va} * FD_{f2,a}^{-\rho_a^{va}} \right) \right]^{-1} * \delta_{f2,a}^{va} * FD_{f2,a}^{(-\rho_a^{va}-1)}$	(f2*a)	$FD_{f2,a}$
(X16)	$QINTD_c = \sum_a \left(ioqtdqd_{c,a} * QINT_a \right)$	c	$QINTD_c$
	Third Level (4th and 5th level are analogue)		
(X17)	$FD_{f2ag,a} = AD_{f2ag,a}^{FD} * \left[\sum_{f3\$\delta_{f2ag,f3,a}^{fd}} \left(\delta_{f2ag,f3,a}^{fd} * FD_{f3,a}^{-\rho_{f2ag,a}^{fd}} \right) \right]^{-1/\rho_{f2ag,a}^{fd}}$	(f2ag*a)	$FD_{f2ag,a}$
(X18)	$WF_{f3} * WFDIST_{f3,a} * \left(1 + TF_{f3,a}\right) = WF_{f2ag} * WFDIST_{f2ag,a} * \left(1 + TF_{f2ag,a}\right) * FD_{f2ag,a} * \left[\sum_{f3\$\delta_{f2ag,f3,a}^{fd}} \left(\delta_{f2ag,f3,a}^{fd} * FD_{f3,a}^{-\rho_{f2ag,a}^{fd}} \right) \right]^{-1} * \delta_{f2ag,f3,a}^{fd} * FD_{f3,a}^{\left(-\rho_{f2ag,a}^{fd}-1\right)}$	(f3*a)	$FD_{f3,a}$

Factors

STAGE-LAB includes a series of migration functions that allow factors (‘natural’ factors, f) to migrate between labour types and thus between sub-nests of the production structure. Net migration is implemented with a constant elasticity supply function for each labour type. A factor migrates between factor types in response to relative wage changes ($WFMIG_{f,mig}$) (*Eq. MG2*), which are defined as changes in factor prices relative to the weighted average factor prices ($AVGWF_{mig}$) (*Eq. MG1*). Each factor type that is allowed to migrate is assigned to a group (mig), which serves as pool where labour migrates in and is distributed from to the destination labour types, factors do not migrate bilateral. The degree of mobility is controlled by the supply elasticities ($etamig_f$), which can vary for factors. In order to keep the total supply of factors constant, a market clearing condition (*Eq. MG3*) concludes the migration setup.

	Equation	Number of Equations and Variables	Variable
	Migration Block		
(M1)	$WFMIG_{f,mig} = \left(\frac{\sum_a \left(WF_f * WFDIST_{f,a} * FD_{f,a}\right)}{\sum_a FD_{f,a}}\right) \Big/ AVGWF_{mig}$	(f*mig)	$WFMIG_{f,mig}$
(M2)	$FS_f = FS0_f * \left(\sum_{mig} \frac{WFMIG_{f,mig}}{WFMIG0_{f,mig}}\right)^{etamig_f}$	F	FS_f
(M3)	$\sum_f FS_f = \sum_f FS0_f \quad \forall\, f\ element\ in\ mig$	mig	$AVGWF_{mig}$

Unemployment is introduced as mixed complementarity problem (MCP; *Eq. U1*). The total supply of a natural factor consists of current total demand and a stock of the factor that is currently unemployed (*Eq. C1*). When there is unemployment, the real wage of that factor is fixed until all unemployed factors are absorbed by demand in the labour market. When the stock of unemployed factors is empty, the real wage rate of this factor is flexible. Thus two segments of labour supply functions are generated: horizontal until full employment and then vertical. More complex structures of a segmented labour supply function are possible, but not implemented in the model. As the wage rates are fixed when there is unemployment, unemployment has implications for labour migration which depends on changes in relative wage rates. There can only be migration when at least one of the factors within a migration pool is fully employed, since only then relative wages change.

	Equation	Number of Equations and Variables	Variable
	Unemployment		
(U1)	$UNEMP_f \geq 0$	f	$UNEMP_f$
	$WF0_f \leq WF_f \leq +\infty \qquad \forall\, uef$		

These extensions, migration and unemployment, increase the degree of realism achieved in the modelling of labour markets. An implication of this increased realism is that the response of factor markets to changes in prices is decreased: the nested structure reduces the extent of substitution possibilities and the migration functions further reduce substitution possibilities.

Factors have two sources of income: first factors receive income (YF_f; *Eq. F1*) from their employment in activities; second factors receive income from employment abroad, which is assumed fixed in terms of the foreign currency. The factor income which is finally distributed to institutions which own these factors ($YFDISP_f$; *Eq. F2*) includes allowances for depreciation rates and factor taxes.

	Equation	Number of Equations and Variables	Variable
	Factor Block		
(F1)	$YF_f = \left(\sum\left(WF_f * WFDIST_{f,a} * FD_{f,a}\right)\right) + \left(factwor_f * ER\right)$	f	YF_f
(F2)	$YFDISP_f = \left(YF_f * \left(1 - deprec_f\right)\right) * \left(1 - TYF_f\right)$	f	$YFDISP_f$

B.3 Institutions

Households

Households (h) receive income (YH_h; *Eq. H1*) from several sources. Income from factors is distributed among households in fixed proportions, according to the distribution of ownership of factors. In addition, households are recipients of inter-household transfers and recipients of governmental transfers, receive income from incorporated enterprises and transfers from the rest of the world.

	Equation	Number of Equations and Variables	Variable
	Household Block		
(H1)	$YH_h = \left(\sum_f \left(hovash_{h,f} * YFDISP_f\right)\right) + \left(\sum_{hp} HOHO_{h,hp}\right) + HOENT_h + \left(hogovconst_h * HGADJ * CPI\right) + \left(howor_h * ER\right)$	h	YH_h
(H2)	$HOHO_{h,hp} = hohosh_{h,hp} * \left(YH_h * (1 - TYH_h)\right) * (1 - SHH_h)$	(h*hp)	$HOHO_{h,h}$
(H3)	$HEXP_h = \left[\left(YH_h * (1 - TYH_h)\right) * (1 - SHH_h)\right] - \left(\sum_h HOHO_{hp,h}\right)$	h	$HEXP_h$
(H4)	$QCD_{c,h} = \frac{PQD_c qcdconst_{c,h} + beta_{c,h}\left(HEXP_h - \sum_c\left(PQD_c qcdconst_{c,h}\right)\right)}{PQD_c}$	(c*h)	$QCD_{c,h}$

Household income is used for consumption expenditures, where households are assumed to maximise utility using Stone-Geary utility functions (*Eq. H4*). In this function, household consumption consists of two components: ‘subsistence’ demand, which is satisfied directly, and ‘discretionary’ demand. This ‘discretionary’ demand is spent out of uncommitted income, i.e., household consumption expenditure ($HEXP_h$) after deducting total expenditure on subsistence demand. Additionally to consumption expenditures, household expenses include transfer payments to other households ($HOHO_{h.hp}$; *Eq. H2*), which are defined in fixed proportions of household income after tax, and income tax payments. Household savings balance total income and total expenditures.

Enterprises

Enterprises consume commodities in fixed volumes ($QED_{c,e}$, *Eq. E2*), which can be varied via an adjuster (QEDADJ). If this adjuster is made flexible, enterprise commodity consumption varies in fixed proportions. After paying income taxes and after saving, enterprises distribute profits or dividends to households ($HOENT_{h,e}$, *Eq. E4*) and to the government ($GOVENT_{h,e}$, *Eq. E5*) in fixed shares of income.

	Equation	Number of Equations and Variables	Variable
	Enterprise Block		
(E1)	$YE_e = \sum_f (entvash_{e,f} * YFDISP_f) + (entgovconst_e * EGADJ * CPI) + (entwor_e * ER)$	E	YE_e
(E2)	$QED_{c,e} = qedconst_{c,e} * QEDADJ$	(c*e)	$QED_{c,e}$
(E3)	$VED_e = \sum_c (QED_{c,e} * PQD_c)$	E	VED_e
(E4)	$HOENT_{h,e} = hoentsh_{h,e} * \left[(YE_e * (1 - TYE_e) * (1 - SEN_e)) - \sum_c (QED_{c,e} * PQD_c) \right]$	(h*e)	$HOENT_{h,e}$
(E5)	$GOVENT_e = goventsh_e * \left[(YE_e * (1 - TYE_e) * (1 - SEN_e)) - \sum_c (QED_{c,e} * PQD_c) \right]$	E	$GOVENT_e$

Government

The numerous tax rates in the model are variable and various possibilities to vary the tax rates are already implemented in the model. The model differentiates import taxes, export taxes, sales taxes, excise taxes, indirect taxes on production, taxes on factor use, factor income taxes and income taxes of households and enterprises (*Eq. T1-T9*). These tax rates generate revenues for the government (*Eq. T10-T17*) and thus government income consists of the eight tax instruments. In addition, the government can receive income from factor ownership, income from enterprises and transfers from abroad (*Eq. G1-G4*). The government consumes commodities in fixed proportions, which can be adjusted with a scaling factor. Other features in the government account, which allow for different macro-economic assumptions, are discussed in section B.4.

	Equation	Number of Equations and Variables	Variable
	Tax Rate Block		
(T1)	$TM_c = \left((tmb_c + dabtm_c) * TMADJ\right) + (DTM * tm01_c)$	cm	TM_c
(T2)	$TE_c = \left((teb_c + dabte_c) * TEADJ\right) + (DTE * te01_c)$	ce	TE_c
(T3)	$TS_c = \left((tsb_c + dabts_c) * TSADJ\right) + (DTS * ts01_c)$	c	TS_c
(T4)	$TEX_c = \left((texb_c + dabtex_c) * TEXADJ\right) + (DTEX * tex01_c)$	c	TEX_c
(T5)	$TX_a = \left((txb_a + dabtx_a) * TXADJ\right) + (DTX * tx01_a)$	a	Tx_a
(T6)	$TF_{f,a} = \left(\left(tfb_{f,a} + dabtf_{f,a}\right) * TMADJ\right) + \left(DTF * tf01_{f,a}\right)$	(f*a)	$TF_{f,a}$
(T7)	$TYF_f = \left(\left(tyfb_f + dabtyf_f\right) * TYFADJ\right) + \left(DTYF * tyf01_f\right)$	f	TYF_f
(T8)	$TYH_h = \left((tyhb_h + dabtyh_h) * TYHADJ\right) + (DTYH * tyh01_h)$	h	TYH_h
(T9)	$TYE_e = \left((tyeb_e + dabtye_e) * TYEADJ\right) + (DTYE * tye01_e)$	e	TYE_e
	Tax Revenue Block		
(T10)	$\mathrm{MTAX} = \sum_c (TM_c * PWM_c * ER * QM_c)$	1	MTAX
(T11)	$\mathrm{ETAX} = \sum_c (TE_c * PWM_c * ER * QE_c)$	1	ETAX
(T12)	$\mathrm{STAX} = \sum_c (TS_c * PQS_c * QQ_c)$	1	STAX
(T13)	$\mathrm{EXTAX} = \sum_c (TEX_c * PQS_c * QQ_c)$	1	EXTAX
(T14)	$\mathrm{ITAX} = \sum_a (TX_a * PX_a * QX_a)$	1	ITAX
(T15)	$\mathrm{FTAX} = \sum_{f,a} \left(TF_{f,a} * WF_{f,a} * WFDIST_{f,a} * FD_{f,a}\right)$	1	FTAX
(T16)	$\mathrm{FYTAX} = \sum_f \left(TYF_f * YF_f * \left(1 - deprec_f\right)\right)$	1	FYTAX
(T17)	$\mathrm{DTAX} = \sum_h (TYH_h * YH_h) + \sum_e (TYE_e * YE_e)$	1	DTAX

	Equation	Number of Equations and Variables	Variable
	Government Block		
(G1)	$YG = MTAX + ETAX + STAX + EXTAX + FTAX + ITAX + FYTAX + DTAX + \sum_{f}(govvash_f * YFDISP_f) + GOVENT + (govwor * ER)$	1	YG
(G2)	$QGD_c = qgdconst_c * QGDADJ$	c	QGD_c
(G3)	$VGD = \sum_{c}(QGD_c * PQD_c)$	1	VGD
(G4)	$EG = \sum_{c}(QGD_c * PQD_c) + \sum_{h}(hogovconst_h * HGADJ * CPI) + \sum_{e}(entgovconst_e * EGADJ * CPI)$	1	EG

Savings and Investment

	Equation	Number of Equations and Variables	Variable
	Savings and Investment Block		
(I1)	$SHH_h = \big((shhb_h + dabshh_h) * SHADJ * SADJ\big) + (DSHH * DS * shh01_h)$	h	SHH_h
(I2)	$SEN_e = \big((sen_e + dabsen_e) * SEADJ * SADJ\big) + (DSEN * DS * sen01_e)$	e	SEN_e
(I3)	$TOTSAV = \sum_{h}(YH_h * (1 - TYH_h) * SHH_h) + \sum_{e}(YE_e * (1 - TYE_e) * SEN_e) + \sum_{f}(YF_f * deprec_f) + KAPGOV + (CAPWOR * ER)$	1	TOTSAV
(I4)	$QINVD_c = (IADJ * qinvdconst_c)$	c	$QINVD_c$
(I5)	$INVEST = \sum_{c}\big(PQD_c * (QINVD_c + dstocconst_c)\big)$	1	*INVEST*

Savings are representing income to the capital account. Total savings (*Eq. I3*) in the economy include savings of households (*Eq. I1*) and savings of enterprises (*Eq. I2*), both modelled with sophisticated possibilities for variation and derived as shares of after tax income. In addition, total savings incorporate allowances for depreciation of factor income, the government budget deficit or surplus and the current account balance. Similar to government and enterprise consumption, the volumes of investment demand for commodities are determined by the volumes in the base period (*Eq. I5*).

Foreign Institutions

The economy employs factors which are owned by the rest of the world. The compensation of these foreign factors is in fixed proportions of factor income available for distribution (after allowing for depreciation and factor taxes) (*Eq. R1*).

	Equation	Number of Equations and Variables	Variable
	Foreign Institutions Block		
(R1)	$YFWOR_f = worvash_f * YFDISP_f$	f	$YFWOR_f$

B.4 Market Clearing and Macro Closures

Market Clearing

The model contains six markets: factor markets, commodity markets, and enterprise, government, capital and rest of the world accounts. To make sure that supply equals demand or income equals expenditure, the model contains several market clearing equations. Activities are transformed to commodities and thus market clearing of domestic produced goods is achieved in equation (*Eq. X16*). In the factor markets, factor supply of a specific type needs to equal aggregated factor demand of this factor type plus the stock of unemployed (*Eq. C1*). This stock of unemployed factors is positive or zero. In the commodity market, the supply of the composite commodity is equal to total domestic demand of that commodity, including intermediate, household, enterprise, government and investment demand and stock changes (*Eq. C2*). Government savings (KAPGOV) clear the government account, which is the residual of government income and government expenditure (*Eq. C3*). Similarly, the rest of world account clears with the balance of the capital account (CAPWOR) being the residual of expenditures on imports (commodity and factor services from abroad) and income from abroad (containing export and factor revenues and transfers from abroad to domestic institutions) (*Eq. C4*).

A slack variable (WALRAS) is included in the market clearing equation for the capital market. Total savings (TOTSAV) must equal total value of investments (INVEST), with the slack variable being zero, when all markets are fully cleared and the model is fully closed (*Eq. C5*).

	Equation	Number of Equations and Variables	Variable
	Account Closure Block		
(C1)	$FS_f = \sum_a FD_{f,a} + UNEMP_f$	f	FS_f
(C2)	$QQ_c = QINTD_c + \sum_h QCD_{c,h} + \sum_e QENTD_{c,e} + QGD_c + QINVD_c + dsocconst_c$	c	QQ_c
(C3)	$CAPGOV = YG - EG$	1	CAPGOV
(C4)	$CAPWOR = \sum_c (pwm_c * QM_c) + \sum_f \left(\frac{YFWOR_f}{ER}\right) - \sum_c (pwe_c * QE_c) - \sum_f factwor_f - \sum_h howor_h - entwor - govwor$	1	CAPWOR
(C5)	$TOTSAV = INVEST + WALRAS$	1	WALRAS

There are several possibilities to specify factor markets. Factors can be full employed and mobile or full employed and immobile across activities, factors can be unemployed or there are restrictions originating from factor demand. These specifications are determined by the interplay of factor supply (FS_f), factor prices (WF_f), sectoral proportions of factor prices ($WFDIST_{f,a}$) and factor demand ($FD_{f,a}$). Typically, for long term projections, factors are assumed mobile and full employed: then the factor price is flexible and factor supply fixed. For short term projections factors might become immobile across activities, i.e., capital, accordingly, factor demand is fixed. For this specification the sectoral factor price proportions need to adjust to clear the factor market. With fixed factor demand, the factor supply is also fixed, thus, the condition that fixes factor supply is now redundant and needs to be relaxed. To maintain the balance of equations and variables, at least one other condition must be imposed: this can be achieved by fixing the sectoral proportions for factor prices for a specific activity (*activ*) ($WFDIST_{f,activ}$), thus, activity specific returns will be defined relative to the return in *activ*. Unemployment can be introduced more sophisticated in the equation system with related variables and equations (*Eq. U1*) or simply via a specification of the factor market clearing. For this purpose, factor supply is set perfectly elastic and factor prices are fixed. In case factor supply might increase unrealistically in simulations, it is possible to include an upper bound on factor supply. Then the variable is not free anymore and the factor price of that factor needs to be unfixed. In another possible specification factor use by an activity might be restricted, for this purpose, factor demand of that activity is fixed ($FD_{f,activ}$) and the sectoral proportion of factor prices relating to this activity are unfixed ($WFDIST_{f,activ}$).

	Factor Market Clearing		
	Factors full employed and mobile	$FS_f = \overline{FS_f}$ $FD_{f,a} = +\infty$	$WF_f = +\infty$[40] $WFDIST_{f,a} = \overline{WFDIST_{f,a}}$
or	Factors full employed and immobile (implement for a single factor or all factors)	$FS_f = +\infty$ $FD_{f,a} = \overline{FD_{f,a}}$	$WF_f = +\infty$ $WFDIST_{f,a} = +\infty$ $WFDIST_{f,activ} = \overline{WFDIST_{f,activ}}$
or	Unemployment with perfectly elastic supply (implement for a single factor or all factors)	$FS_f = +\infty$ $FD_{f,a} = +\infty$	$WF_f = \overline{WF_f}$ $WFDIST_{f,a} = \overline{WFDIST_{f,a}}$
or	Unemployment with restricted supply (implement for a single factor or all factors)	$FS_f \leq \overline{FS0_f}$ $FD_{f,a} = +\infty$	$WF_f = +\infty$ $WFDIST_{f,a} = \overline{WFDIST_{f,a}}$
or	Activity inspired restrictions on factor market closures (implement for single activities but not all factors)	$FS_f = \overline{FS_f}$ $FD_{f,a} = +\infty$ $FD_{f,activ} = \overline{FD_{f,activ}}$	$WF_f = +\infty$ $WFDIST_{f,a} = \overline{WFDIST_{f,a}}$ $WFDIST_{f,activ} = +\infty$

Macro Closures

The specification of macro-economic closures is important for the operating of the economic system and clearly affects adjustment processes in simulations. STAGE-LAB embodies various closure rules, allowing, e.g., for the choice between a Keynesian view on the economy, where the economy is driven by demand and investment, or a neo-classical view, where the economy is savings driven.

In order to allow for a 'balanced macroeconomic closure', with which it is possible to guard expenditure shares of the agents of the economy, STAGE-LAB contains a series of equations which define absorption as well as non-household agents' expenditure shares (*Eq. A1-A4*), which can be useful in setting up macro-economic closures. Absorption is the total value of final domestic demand including household, enterprise and government demand, intermediate demand and stock changes. Additionally, the model contains a useful equation for calculation of GDP from value added.

[40] In GAMS the solver PATH, which is applied to solve the model, demands variables to be defined as free variables with a range between plus and minus infinity. However, the model specifications ensure that variables stay inside the economically meaningful range.

	Equation	Number of Equations and Variables	Variable
	Absorption Block		
(A1)	$VFDOMD = \sum_c PQD_c * \left(\sum_h QCD_{c,h} + \sum_e QENTD_{c,e} + QGD_c + QINVD_c + dsocconst_c\right)$	1	VFDOMD
(A2)	$VENTSH = {VENTD}/{VFDOMD}$	1	VENTDSH
(A3)	$VGDSH = {VGD}/{VFDOMD}$	1	VGDSH
(A4)	$INVESTSH = {INVEST}/{VFDOMD}$	1	INVESTSH

The current account can be defined either with a fixed exchange rate and a flexible current account balance, assuming an inflexible currency system, or the current account balance is fixed and the exchange rate floating, which is appropriate for countries, which, e.g., follow structural account programmes. Assuming a small country as typical setup, world market prices are fixed. As world market prices (PWE and PWM) are defined as variables, the small country assumption may be dropped for the country or for specific commodities: then world market prices become flexible, with an export demand function determining the export price (*Eq. EX4*).

	Current Account Closure:		
	Fix exchange rate regime	$ER = \overline{ER}$	$CAPWOR = \pm\infty$
or	Fix current account balance	$ER = +\infty$	$CAPWOR = \overline{CAPWOR}$
	Small country assumption	$PWM_c = \overline{PWM_c}$ $PWE_c = \overline{PWE_c}$	
or	Large export country for good c	$PWM_c = \overline{PWM_c}$ $PWE_c = +\infty$	Activates eq. (EX4)

For the capital account closure, savings can either be investment driven or investment is savings driven. When investment is savings driven, hence, savings are to be fixed (neo-classical approach), all saving rates adjusters – additive and multiplicative – are fixed (*Eq. I1-I2*) and investment free to adjust. Investment driven savings (Keynesian approach) can be achieved in several ways. On the investment side, either the value of investment (INVEST), the investment scaling factor (IADJ) or the share of investment in total final demand can be fixed. If investment is fixed, the model needs to adjust by changes in the savings rate, hence, one of the saving rates adjusters are made flexible. There the choice is between multiplicative and additive adjusters. Furthermore, for both types of saving rates adjusters, the saving rate can become flexible only for households (SHADJ/DSHH) or enterprises (SEADJ/DSEN) or savings rates of households change equiproportionate (SADJ/DS).

	Capital Account Closure:		
	Savings driven investment	Multiplicative Adjusters: $SADJ = \overline{SADJ}$ $SHADJ = \overline{SHADJ}$ $SEADJ = \overline{SEADJ}$ Additive Adjusters: $DS = \overline{DS}$ $DSHH = \overline{DSHH}$ $DSEN = \overline{DSEN}$	$IADJ = +\infty$; $INVEST = +\infty$; $INVESTSH = +\infty$
or	Investment driven savings	One savings rate adjuster (multiplicative or additive) becomes flexible, all others stay fixed.	One is fixed, two stay variable: $IADJ = \overline{IADJ}$ $or\ INVEST = \overline{INVEST}$ $or\ INVESTSH = \overline{INVESTSH}$

The enterprise account can be closed by fixing the quantity of commodities demanded (QEADJ), which allows the value of enterprise consumption expenditure to vary according to price changes. Alternatively the value of consumption expenditures by enterprises (VED) or the share of enterprise expenditure in the total value of final demand (VEDSH) can be fixed.

	Enterprise Account Closure	
	Fix one of the variables	$QEADJ = \overline{QEADJ}$ $or\ VED = \overline{VED}$ $or\ VEDSH = \overline{VEDSH}$

	Government Account Closure		
	Flexible internal balance	$TMADJ = \overline{TMADJ}$ $TEADJ = \overline{TEADJ}$ $TSADJ = \overline{TSADJ}$ $TEXADJ = \overline{TEXADJ}$ $TXADJ = \overline{TXADJ}$ $TFADJ = \overline{TFADJ}$ $TYFADJ = \overline{TYFADJ}$ $TYHADJ = \overline{TYHADJ}$ $TYEADJ = \overline{TYEADJ}$	One is fixed, two stay variable: $QGDADJ = \overline{QGDADJ}$ $or\ VGD = \overline{VGDJ}$ $or\ VGDSH = \overline{VGDSH}$; $HGADJ = \overline{HGADJ}$ $EGADJ = \overline{EGADJ}$
		$DTM = \overline{DTM}$ $DTE = \overline{DTE}$ $DTS = \overline{DTS}$ $DTEX = \overline{DTEX}$ $DTX = \overline{DTX}$ $DTF = \overline{DTF}$ $DTYF = \overline{DTYF}$ $DTYH = \overline{DTYH}$ $DTYE = \overline{DTYE}$	$KAPGOV = \pm\infty$
or	Fix internal balance		$KAPGOV = \overline{KAPGOV}$
		Unfix ***either*** one of the tax rate adjusters	***or*** one of the fixed government expenditure parameters.

In the base specification for the government account, all tax rates are fixed, assuming government income to be 'fixed' and government savings variable. Base tax rates are defined as parameters, which can be adjusted with multiplicative and additive tax rate scaling factors, defined as variables (*Eq. T1-T16*). Thus, technically these scaling factors are fixed. The two other sources of government income, income from factor ownership and transfers from abroad, are governed by parameters. Government expenditure is controlled by fixing the quantity of commodities demanded (QGDADJ) (*Eq. G2-G3*), the value of government consumption expenditure (VGD) or the share of government expenditure in the total value of domestic final demand (VGDSH). The scaling factor on transfers to households (HGADJ) and enterprises (EGADJ) need to be fixed. With this specification, all parameters, which the government can control, are fixed and the internal balance (government savings) is free to adjust. If the government is assumed to maintain the internal balance, one of the tax rate adjusters needs to become flexible.

Finally, one of the two price normalisation equations, consumer price index or producer price index (*Eq. N1-N2*), needs to be chosen to serve as numéraire.

	Numéraire Closure		
	Producer price as numéraire	$PPI = \overline{PPI}$	$CPI = +\infty$
or	Consumer price as numéraire	$PPI = +\infty$	$CPI = \overline{CPI}$

B.5 Parameter, Variables and Sets Listing

Table B.1. Alphabetical List of Parameters

Parameter Name	Parameter Description	Parameter Name	Parameter Description
ac(c)	Shift parameter for Armington CES function	gamma(c)	Share parameter for Armington CET function
actcomactsh(a,c)	Share of commodity c in output by activity a	goventsh(e)	Share of entp' income after tax save and consump to govt
actcomcomsh(a,c)	Share of activity a in output of commodity c	govvash(f)	Share of income from factor f to government
adva(a)	Shift parameter for CES production functions for QVA	govwor	Transfers to government from world (constant in foreign currency)
adx(a)	Shift parameter for CES production functions for QX	hexps(h)	Subsistence consumption expenditure
adxc(c)	Shift parameter for commodity output CES aggregation	hoentconst(h,e)	Transfers to hhold h from enterprise e (nominal)
alphah(c,h)	Expenditure share by commodity c for household h	hoentsh(h,e)	Share of entp' income after tax save and consump to h'hold
at(c)	Shift parameter for Armington CET function	hogovconst(h)	Transfers to hhold h from government (nominal but scalable)
beta(c,h)	Marginal budget shares	hohoconst(h,hp)	Interhousehold transfers
caphosh(h)	Shares of household income saved (after taxes)	hohosh(h,hp)	Share of h'hold h after tax and saving income transferred to hp
comactactco(c,a)	Intermediate input output coefficients	hovash(h,f)	Share of income from factor f to household h
comactco(c,a)	Use matrix coefficients	howor(h)	Transfers to household from world (constant in foreign currency)
comentconst(c,e)	Enterprise demand volume	invconst(c)	Investment demand volume
comgovconst(c)	Government demand volume	ioqintqx(a)	Agg intermed quantity per unit QX for Level 1 Leontief agg
comhoav(c,h)	Household consumption shares	ioqvaqx(a)	Agg value added quant per unit QX for Level 1 Leontief agg
comtotsh(c)	Share of commodity c in total commodity demand	kapentsh(e)	Average savings rate for enterprise e out of after tax income
dabte(c)	Change in base export taxes on comm'y imported from region w	predeltax(a)	Dummy used to estimated deltax
dabtex(c)	Change in base excise tax rate	pwse(c)	World price of export substitutes
dabtfue(c)	Change in base fuel tax rate	qcdconst(c,h)	Volume of subsistence consumption
dabtm(c)	Change in base tariff rates on comm'y imported from region w	rhoc(c)	Elasticity parameter for Armington CES function
dabts(c)	Change in base sales tax rate	rhocva(a)	Elasticity parameter for CES production function for QVA
dabtx(a)	Change in base indirect tax rate	rhocx(a)	Elasticity parameter for CES production function for QX
dabtye(e)	Change in base direct tax rate on enterprises	rhocxc(c)	Elasticity parameter for commodity output CES aggregation
dabtyf(f)	Change in base direct tax rate on factors	rhot(c)	Elasticity parameter for Output Armington CET function
dabtyh(h)	Change in base direct tax rate on households	sumelast(h)	Weighted sum of income elasticities
delta(c)	Share parameter for Armington CES function	te01(c)	0-1 par for potential flexing of export taxes on comm'ies
deltava(f,a)	Share parameters for CES production functions for QVA	tex01(c)	0-1 par for potential flexing of excise tax rates
deltax(a)	Share parameter for CES production functions for QX	tfue01(c)	0-1 par for potential flexing of fuel tax rates
deltaxc(a,c)	Share parameters for commodity output CES aggregation	tm01(c)	0-1 par for potential flexing of Tariff rates on comm'ies
deprec(f)	Depreciation rate by factor f	ts01(c)	0-1 par for potential flexing of sales tax rates
dstocconst(c)	Stock change demand volume	tx01(a)	0-1 par for potential flexing of indirect tax rates
econ(c)	Constant for export demand equations	tye01(e)	0-1 par for potential flexing of direct tax rates on e'rises
entgovconst(e)	Government transfers to enterprise e	tyf01(f)	0-1 par for potential flexing of direct tax rates on factors
entvash(e,f)	Share of income from factor f to enterprise e	tyh01(h)	0-1 par for potential flexing of direct tax rates on h'holds
entwor(e)	Transfers to enterprise e from world (constant in foreign currency)	use(c,a)	Use matrix transactions
etamig(f)	Migrant supply elasticity	vddtotsh(c)	Share of value of domestic output for the domestic market
eta(c)	Export demand elasticity	worvash(f)	Share of income from factor f to RoW
factwor(f)	Factor payments from RoW (constant in foreign currency)	yhelast(c,h)	(Normalised) household income elasticities
frisch(h)	Elasticity of the marginal utility of income		

Table B.2. Alphabetical List of Variables

Variable Name	Variable Description	Variable Name	Variable Description	Variable Name	Variable Description
AVGWF(mig)	Avg wage in mig - wage that clears mig equilibrium	PD(c)	Consumer price for domestic supply of commodity c	TEADJ	Export subsidy Scaling Factor
CAPGOV	Government Savings	PE(c)	Domestic price of exports by activity a	TEX(c)	Excise tax rate
CAPWOR	Current account balance	PINT(a)	Price of aggregate intermediate input	TEXADJ	Excise tax rate scaling factor
CPI	Consumer price index	PM(c)	Domestic price of competitive imports of commodity c	TFUE(c)	Fuel tax rate
DTAX	Direct Income tax revenue	PPI	Producer (domestic) price index	TFUEADJ	Fuel tax rate scaling factor
DTE	Partial Export tax rate scaling factor	PQD(c)	Purchaser price of composite commodity c	TM(c)	Tariff rates on imported comm'y c
DTEX	Partial Excise tax rate scaling factor	PQS(c)	Supply price of composite commodity c	TMADJ	Tarrif rate Scaling Factor
DTFUE	Partial Fuel tax rate scaling factor	PVA(a)	Value added price for activity a	TOTSAV	Total savings
DTM	Partial Tariff rate scaling factor	PWE(c)	World price of exports in dollars	TS(c)	Sales tax rate
DTS	Partial Sales tax rate scaling factor	PWM(c)	World price of imports in dollars	TSADJ	Sales tax rate scaling factor
DTX	Partial Indirect tax rate scaling factor	PX(a)	Composite price of output by activity a	TX(a)	Indirect tax rate
DTYE	Partial direct tax on enterprise rate scaling factor	PXAC(a,c)	Activity commodity prices	TXADJ	Indirect Tax Scaling Factor
DTYF	Partial direct tax on factor rate scaling factor	PXC(c)	Producer price of composite domestic output	TYE(e)	Direct tax rate on enterprises
DTYH	Partial direct tax on household rate scaling factor	QCD(c,h)	Household consumption by commodity c	TYEADJ	Enterprise income tax Scaling Factor
EG	Expenditure by government	QD(c)	Domestic demand for commodity c	TYF(f)	Direct tax rate on factor income
EGADJ	Transfers to enterprises by government Scaling Factor	QE(c)	Domestic output exported by commodity c	TYFADJ	Factor Tax Scaling Factor
ER	Exchange rate (domestic per world unit)	QENTD(c,e)	Enterprise consumption by commodity c	TYH(h)	Direct tax rate on households
ETAX	Export tax revenue	QENTDADJ	Enterprise demand volume Scaling Factor	TYHADJ	Household Income Tax Scaling Factor
EXTAX	Excise tax revenue	QGD(c)	Government consumption demand by commodity c	UNEMP(f)	Unemployed factor
FD(f,a)	Demand for factor f by activity a	QGDADJ	Government consumption demand scaling factor	VENTD(e)	Value of enterprise e consumption expenditure
FS(f)	Supply of factor f	QINT(a)	Aggregate quantity of intermediates used by activity a	VENTDSH(e)	Value share of Ent consumption in total final demand
FUETAX	Fuel tax revenue	QINTD(c)	Demand for intermediate inputs by commodity	VFDOMD	Value of final domestic demand
FYTAX	Factor Income tax revenue	QINVD(c)	Investment demand by commodity c	VGD	Value of Government consumption expenditure
GOVENT(e)	Government income from enterprise e	QM(c)	Imports of commodity c	VGDSH	Value share of Govt consumption in total final demand
HEADJ	Scaling factor for enterprise transfers to households	QQ(c)	Supply of composite commodity c	WALRAS	Slack variable for Walras's Law
HEXP(h)	Household consumption expenditure	QVA(a)	Quantity of aggregate value added for level 1 production	WF(f)	Price of factor f
HGADJ	Scaling factor for government transfers to households	QX(a)	Domestic production by activity a	WFMIG(f,mig)	Wage comparison used to make migration decision
HOENT(h,e)	Household Income from enterprise e	QXAC(a,c)	Domestic commodity output by each activity	WFDIST(f,a)	Sectoral proportion for factor prices
HOHO(h,hp)	Inter household transfer	QXC(c)	Domestic production by commodity c	YE(e)	Enterprise incomes
IADJ	Investment scaling factor	SADJ	Savings rate scaling factor for households and enterprises	YF(f)	Income to factor f
INVEST	Total investment expenditure	SEADJ	Savings rate scaling factor for enterprises	YFDISP(f)	Factor income for distribution after depreciation
INVESTSH	Value share of investment in final domestic demand	SHADJ	Savings rate scaling factor for households	YFWOR(f)	Foreign factor income
ITAX	Indirect tax revenue	STAX	Sales tax revenue	YG	Government income
MTAX	Tariff revenue	TE(c)	Export taxes on exported comm'y c	YH(h)	Income to household h

Table B.3. List of Sets and Subsets

Set Name	Set Description	Set Name	Set Description	Set Name	Set Description
sac	SAM accounts	ff(sac)	Factors	h(sac)	Households
c(sac)	Commodities	f(ff)	Natural Factors	g(sac)	Government
cagr(c)	Agricultural Commodities	l(f)	Labour Factors	gt(sac)	Government tax accounts
cnat(c)	Natural Resource Commodities	ls(l)	Skilled Labour Factors	tff(sac)	Factor tax account used in GDX program
cfd(c)	Food Commodities	lm(l)	Skilled or Unskilled Labour Factors	e(sac)	Enterprises
cind(c)	Industrial Commodities	lu(l)	Unskilled Labour Factors	i(sac)	Investment
cuti(c)	Utility Commodities	uef(f)	Factors with unemployment	w(sac)	Rest of the world
ccon(c)	Construction Commodities	fag(ff)	Aggregate factors	sacn(sac)	SAM accounts excluding TOTAL
cser(c)	Service Commodities	f2(ff)	Factor inputs to QVA at level 1	ss	ASAM categories
cagg	Aggregate commodity groups	f2ag(ff)	Aggregate factors at level 2	ssn(ss)	ASAM excluding totals
ce(c)	Export commodities	f3(ff)	Factor inputs to aggregate factors at level 2	fcons	Set for parameters controlling program flow
cen(c)	Non-export commodities	f3ag(ff)	Aggregate factors at level 3	mcons	Set for parameters controlling model content
ced(c)	Export commodities with export demand functions	f4(ff)	Factor inputs to aggregate factors at level 3	sigc	Set for commodity elasticities
cedn(c)	Export commodities without export demand functions	f4ag(ff)	Aggregate factors at level 4	siga	Set for activity elasticities
cm(c)	Imported commodities	f5(ff)	Factor inputs to aggregate factors at level 4	sigfd(siga)	Set for aggregate factor elasticities
cmn(c)	Non-imported commodities	k(ff)	Capital Factors	ppn	Population
cx(c)	Commodities produced domestically	n(ff)	Land factors		
cxn(c)	Commodities NOT produced domestically AND imported	map_f_tff(f,tff)	Factor taxes to factors		
cxac(c)	Commodities that are differentiated by activity	map_tff_f(tff,f)	Factor taxes to factors reverse		
cxacn(c)	Commodities that are NOT differentiated by activity	map_aagg_a(aagg,a)	Mapping from act. to aggregate act.		
cd(c)	Commodities produced and demanded domestically	map_cagg_c(cagg,c)	Mapping from com. to aggregate com.		
cdn(c)	Commodities NOT produced and demanded domestically	map_f4ag_f5(f4ag,f5)	Mapping to F4ag from f5		
m(sac)	Margins	map_f3ag_f4(f3ag,f4)	Mapping to F3ag from f4		
a(sac)	Activities	map_f2ag_f3(f2ag,f3)	Mapping to F2ag from f3		
aagr(a)	Agricultural Activities	map_fag_f(ff,f)	Mapping to fag from f		
anat(a)	Natural Resource Activities	map_fag_fa(ff,ff)	Mapping to aggregates		
afd(a)	Food Activities	mig	Migration flows		
aind(a)	Industrial Activities	map_mig_f(mig,f)	Migration mapping		
auti(a)	Utility Activities				
acon(a)	Construction Activities				
aser(a)	Service Activities				
aagg	Aggregate activity groups				
anch(a)	Anchor activity for fixing 1 WFDIST in various factor closures				
anchN(a)	Anchor activity for fixing 1 WFDIST in land factor closures				
aleon(a)	Activities with Leontief prodn function at Level 1				
aqx(a)	Activities with CES aggregation function at Level 1 of nest				
aqxn(a)	Activities with Leontief aggregation function at Level 1 of nest				

B.6 Adaption to Israel: Elasticities

The accounts used in the model for Israel are identified by the Israeli SAM, which is described in section A of the Appendix, i.e., see section A.3 for a full list of accounts and specifications of the database for model purposes. In addition to the data reported by the SAM, which reports transaction payments and thus values, the model employs two additional datasets. First, in order to be able to distinguish between factor prices and quantities on factor type as well as activity level, a factor use matrix completes the SAM. This factor use matrix reports real quantities for a factor by activity matrix.

Second, a series of elasticities govern the strength of responses to model simulations. Elasticities and its values in the different publications are displayed in Table B.4 and Table B.5. Elasticity values are derived from literature where possible, mainly following the GTAP model (compare Hertel, 1997) (*EL1-EL4, EL6* and *EL8-EL9*), or are based on educated guesses. Table B.4 reports commodity elasticities, which are generally set uniform for all commodities with one exemption: The sector 'other crops' is characterised by large import shares and simultaneously large export shares of over 30%. The simulation of increasing world market prices for 'other crops' with the Armington elasticities (*EL1* and *EL2*) set equal to 2 results in exploding exports of this sector. The Armington elasticities are therefore set to a more inelastic level in the productivity paper, where world market price changes are simulated.

The series of CES-elasticities in the nested production functions (*7a-7k*) refers to the five level nest adopted for the model for Israel displayed in Figure C.1 (section C.1) of the Appendix. Estimations on substitution elasticities of labour demand are not available, except for the substitution between skilled and unskilled workers (Boeters and Savard, 2013). For article 1 *'Relaxing Israeli Restrictions on Labour: Who Benefits?'* values are thus based on educated guesses about relative relationships. Skilled and unskilled labour (where the elasticity value is based on empirics) are least substitutable and better substitutability is assumed in the sub-nests. With Jewish and Non-Jewish Israeli being less good substitutes than male and female as well as foreigners from ROW and from Palestine[41]. In article 3 on *'Labour Market Flexibility and Costs of Adjustment'* the relative relationships persist, but with a lower level because the migration extension has problems to handle a very strong substitutability. The reason for this sensitivity against the substitution elasticity can be found in the data, which indicates strong wage differences inside a migration group (see Table III.1. in section III.3.1). Here, in-migration causes a sudden change in the relative wage rate, if the factor demand reacts too elastic it develops a circular. When wage differences inside a migration group are smaller, substitution elasticities can be increased. In article 2 on '*Factor Mobility and Heterogeneous Labour*', these effects are very strong, because simulations are set to induce strong factor movements. Therefore all substitution elasticities are set 1.5 (following skilled and unskilled). Due to aggregation of labour groups, some elasticities become irrelevant in paper 2 and 3.

[41] For more detail in considerations about nesting and substitutability please see section II.3.2.

Table B.4. Commodity and Activity Elasticities

		for	Labour integration	productivity paper	reallocation costs
(EL1)	Armington CES elasticities	c	2.0	2.0	2.0
		'Other crops'	2.0	0.9	2.0
(EL2)	Armington CET elasticities	c	2.0	2.0	2.0
		'Other crops'	2.0	0.9	2.0
(EL3)	Export demand	c	0.0	0.0	0.0
(EL4)	Commodity output	c	4.0	4.0	4.0
(EL5)	σ_1: CES-elasticities for QX	a	0.5	0.5	0.5
(EL6)	σ_{22}:CES-elasticities for QVA	a	0.8	0.8	0.8
(EL7)	CES-elasticities in nested production functions:				
(EL7a)	σ_{31}: Labor	a	1.5	1.5	1.5
(EL7b)	σ_{41}: Skilled	a	4.0	1.5	3.0
(EL7c)	σ_{42}: Unskilled	a	4.0	1.5	3.0
(EL7d)	σ_{51}: Skilled Israeli Jews	a	6.0	n.r	n.r
(EL7e)	σ_{52}: Skilled Israeli Arabs	a	6.0	n.r	n.r
(EL7f)	σ_{53}: Unskilled Israelis	a	4.0	1.5	3.0
(EL7g)	σ_{54}: Unskilled non-Israelis	a	6.0	1.5	4.5
(EL7h)	σ_{61}: Unskilled Israeli Jews	a	6.0	n.r	n.r
(EL7i)	σ_{62}: Unskilled Israeli Arabs	a	6.0	n.r	n.r
(EL7j)	σ_{63}: Foreigners from ROW	a	8.0	n.r	n.r
(EL7k)	σ_{64}: Palestinians	a	8.0	n.r	n.r

Table B.5. Frisch and Income Elasticities[42]

	Jewish households, income quintiles					Arab and Other households, income quintiles				
	1st	2nd	3rd	4th	5th	1st	2nd	3rd	4th	5th
(EL8) Frisch elasticities	-1.6	-1.3	-1.05	-1.05	-1.05	-1.6	-1.3	-1.05	-1.05	-1.05
(EL9) Income elasticities:										
Wheat	0.4	0.3	0.2	0.1	0.05	0.4	0.3	0.2	0.1	0.05
Cereals	0.4	0.3	0.2	0.1	0.05	0.4	0.3	0.2	0.1	0.05
Other crops	0.4	0.3	0.2	0.1	0.05	0.4	0.3	0.2	0.1	0.05
Milk	0.6	0.5	0.4	0.3	0.2	0.6	0.5	0.4	0.3	0.2
Bovine cattle, sheep, goats, and horses	0.6	0.5	0.4	0.3	0.2	0.6	0.5	0.4	0.3	0.2
Other animal farming	0.6	0.5	0.4	0.3	0.2	0.6	0.5	0.4	0.3	0.2
Fruits and vegetables	0.6	0.5	0.4	0.3	0.2	0.6	0.5	0.4	0.3	0.2
Fishing	0.6	0.5	0.4	0.3	0.2	0.6	0.5	0.4	0.3	0.2
Gardening, and mixed and unclassified farming	0.6	0.5	0.4	0.3	0.2	0.6	0.5	0.4	0.3	0.2
Coal, oil, and gas	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Minerals nec	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Meat products nec	0.8	0.65	0.5	0.35	0.2	0.8	0.65	0.5	0.35	0.2
Processing of fruit, vegetables and fish	0.8	0.65	0.45	0.35	0.25	0.8	0.65	0.45	0.35	0.25
Manufacture edible oils, margarine, oil products	0.8	0.65	0.45	0.35	0.25	0.8	0.65	0.45	0.35	0.25
Dairy Products	0.8	0.65	0.45	0.35	0.25	0.8	0.65	0.45	0.35	0.25
Manufacture of grain-mill products	0.4	0.3	0.2	0.1	0.05	0.4	0.3	0.2	0.1	0.05
Other food products	0.8	0.65	0.45	0.35	0.25	0.8	0.65	0.45	0.35	0.25
Beverages and tobacco manufacturing	0.8	0.65	0.45	0.35	0.25	0.8	0.65	0.45	0.35	0.25
Textiles	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Wearing apparel	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Leather products	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Wood products	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Paper products and publishing	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Petroleum and coal products	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Chemical, rubber, and plastic products	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Mineral non-metallic products	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Basic metal	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Metal products (excl. machine. and equipment)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Motor vehicles and parts	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Electronic equipment	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Machinery and equipment nec	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Manufactures nec	2	2	2	2	2	2	2	2	2	2
Electricity	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Water	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Construction	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Trade services	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Transport and business services nec.	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Water transport	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Air transport	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Communication	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Public Administration, Defense, Educ., Health	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Recreational and other services	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Dwellings	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2

[42] Same for all publications.

C. Model Changes

The base model presented in section B of the Appendix is adjusted and extended for the studies which build the main part of the dissertation report. These changes in the model and the implementation of new features into the model framework are presented in this section in more technical detail than possible in a journal article. Section C.1 describes the labour market nesting, adapted to the Israeli labour market, which is first and in detail discussed in article 1 in section II and represents the base for all studies of this thesis. Based on the labour nesting, section C.2 provides technical details on the migration function, implemented in article 2 and article 3 in sections III and IV. Finally the implementation of factor specific productivity is set on top of the migration function, which is presented in section C.3.

C.1 Setup of the Nesting Structure

Nested CES Production Function

In STAGE-LAB, output is formed by a series of nested CES-functions, which is very flexible in form (Perroni and Rutherford, 1995). In the base version of the STAGE-LAB, production is depicted by a five level CES production nest (Section B.2, *Eq. X10* and *Eq. X14-X20*). The form is flexible with natural factors (f) at the lowest level of each branch of the nested structure. These natural factors form an aggregated factor (fag) on the next level, which itself, together with natural or aggregate factors, can form an aggregate on the next upper level (Figure C.1).

The Constant Elasticity of Substitution (CES) function has the following basic form, with two input factors (K and L) forming output (q) (e.g., Nicholoson and Snyder, 2008):

$$q = f(K, L) = [\delta K^{\rho} + (1-\delta)L^{\rho}]^{\frac{\epsilon}{\rho}} \qquad \forall\ \rho \leq 1, \rho \neq 0\ and\ \epsilon > 0$$

Variations of ϵ allow the introduction of returns-to-scale: $\epsilon > 1$ indicate increasing returns-to-scale, $\epsilon < 1$ indicates decreasing returns-to-scale and when $\epsilon = 1$ returns-to-scale are assumed constant. Distributional weights, which indicate the relative significance of inputs, are introduced by δ. The substitution elasticity σ can be directly derived from ρ with

$$\sigma = \frac{1}{1-\rho}.$$

Starting with the second level, the aggregate value added is formed by factors of the second level, which can be either natural factors or aggregate factors themselves. Where $\delta^{a}_{f2,a}$ are the distributional weights and $\rho^{va}_{f2,a}$ is the elasticity parameter (not the elasticity) for the CES production function of QVA_a. The sum is over all *f2* of one sub-nest which form together aggregate value added. AD^{va}_{a} is a shift parameter, which allows simulations of technical progress.

$$QVA_a = AD^{va}_a * \left[\sum_{f2\$\delta^{va}_{f2,a}} \left(\delta^{va}_{f2,a} * FD_{f2,a}^{-\rho^{va}_a}\right)\right]^{-1/\rho^{va}_a} \qquad \text{(X14)}$$

The optimal factor use (FD_{f2}), is determined by the relative prices of inputs. Activities are assumed to maximise profit, which is defined as difference between turnover and total costs:

$$Profit = QVA_a * PVA_a - \sum_{f2}\left(WF_{f2} * WFDIST_{f2,a} * \left(1 + TF_{f2,a}\right)\right).$$

The optimal input combination can be derived with the Lagrange approach for optimisation:

$$L = QVA_a * PVA_a - \sum_{f2}\left(WF_{f2} * WFDIST_{f2,a} * \left(1 + TF_{f2,a}\right)\right) - \boldsymbol{\lambda}[AD_a^{va} * \left[\sum_{f2\$\delta_{f2,a}^{va}}\left(\delta_{f2,a}^{va} * FD_{f2,a}^{-\rho_a^{va}}\right)\right]^{-1/\rho_a^{va}} - QVA_a]$$

(1) $\frac{\delta L}{\delta FD_{f2}} = -WF_{f2} * WFDIST_{f2,a} * \left(1 + TF_{f2,a}\right) - \boldsymbol{\lambda}\left(\frac{-1}{\rho_a^{va}}\right) AD_a^{va}\left[\sum_{f2\$\delta_{f2,a}^{va}} \delta_{f2,a}^{va} * FD_{f2,a}^{-\rho_a^{va}}\right]^{-1/\rho_a^{va}-1} * (-\rho_a^{va}) * \delta_{f2,a}^{va} * FD_{f2,a}^{-\rho_a^{va}-1}$

(2) $\frac{\delta L}{\delta QVA_a} = PVA_a - \boldsymbol{\lambda} * (-1)$

$$(1)/(2): \frac{\frac{\delta L}{\delta FD_{f2}}}{\frac{\delta L}{\delta QVA_a}} = \frac{-WF_{f2} * WFDIST_{f2,a} * \left(1 + TF_{f2,a}\right)}{PVA_a} = \frac{\boldsymbol{\lambda}\left(\frac{-1}{\rho_a^{va}}\right) AD_a^{va}\left[\sum_{f2\$\delta_{f2,a}^{va}} \delta_{f2,a}^{va} * FD_{f2,a}^{-\rho_a^{va}}\right]^{-1/\rho_a^{va}-1} * (-\rho_a^{va}) * \delta_{f2,a}^{va} * FD_{f2,a}^{-\rho_a^{va}-1}}{\boldsymbol{\lambda} * (-1)}$$

Thus the related first order derivative for profit maximisation is

$$WF_{f2} * WFDIST_{f2,a} * \left(1 + TF_{f2,a}\right)$$

$$= PVA_a * QVA_a * AD_a^{va}\left[\sum_{f2\$\delta_{f2,a}^{va}}\left(\delta_{f2,a}^{va} * FD_{f2,a}^{-\rho_a^{va}}\right)\right]^{-1} * \delta_{f2,a}^{va} * FD_{f2,a}^{(-\rho_a^{va}-1)}. \qquad \text{(X15)}$$

Model Adjustments

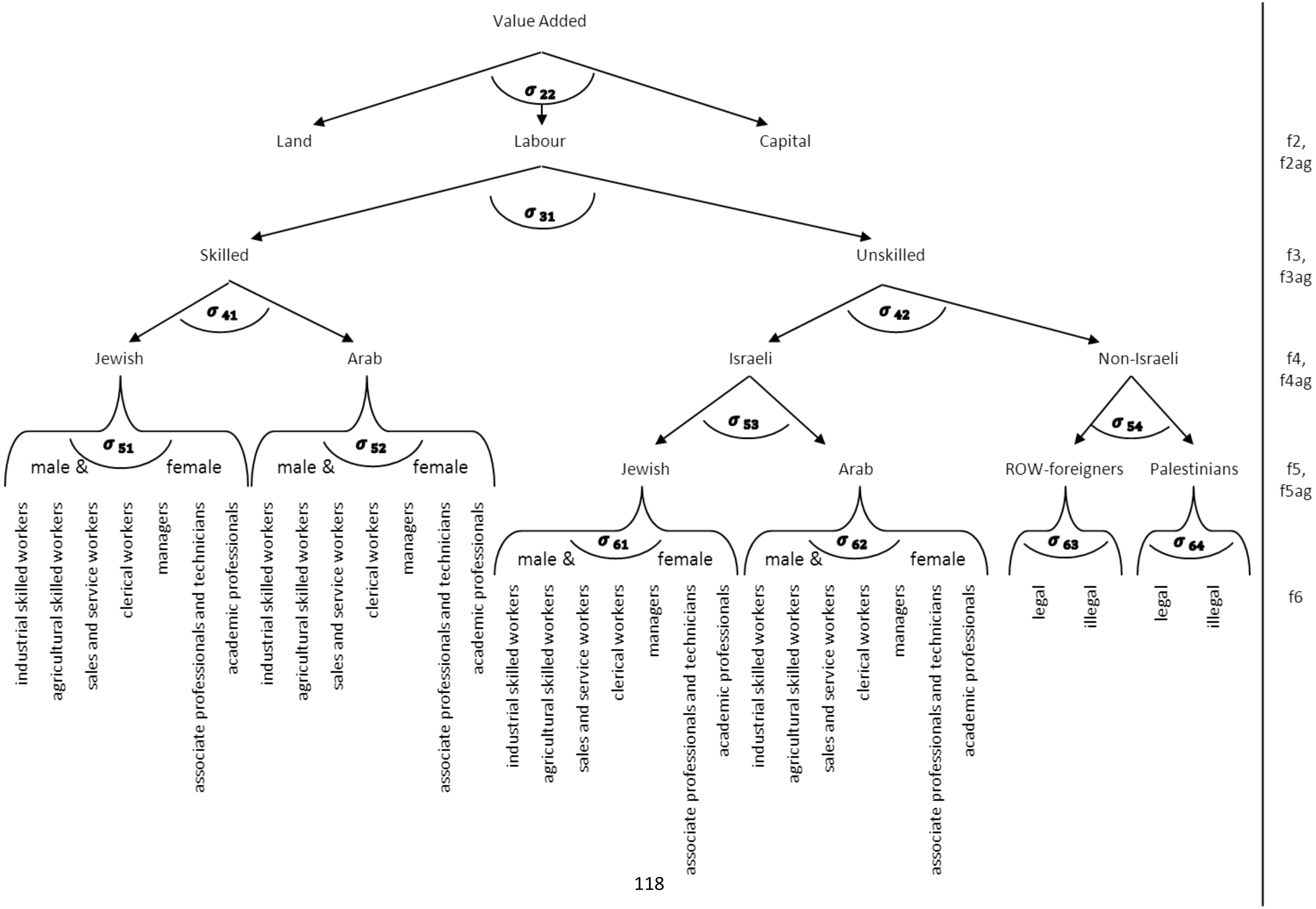
The value added nesting in the model for Israel is set up as displayed in Figure C.1 and the economic background behind the nesting structure is explained in section II.3.2. Value added, in the first level, is an aggregation of the set f2 (factors on the 2nd level), which consists of the natural factors land and capital as well as aggregated labour. Aggregated labour (f2ag: aggregated factors on the 2nd level) is formed of skilled and unskilled labour (f3). Following the skilled branch of the nesting, skilled labour (f3ag) directly substitutes Jewish and Arab Israeli workers (f4,f4ag), which are themselves aggregates of labour types of different occupations and gender (f5) distinguished by ethnicity (Jewish or Arab-Israeli). In the unskilled branch, unskilled labour (f3ag) is formed by Israeli and non-Israeli labour (f4). The Israeli unskilled labour branch is similar to skilled labour, displaced by one level. At the unskilled non-Israeli nest (f4ag) foreigners from Rest of the World (ROW) and Palestinians (f5, f5ag) are direct substitutes, and both are themselves aggregates of legal and illegal workers (f6). This structure of the value added nesting is used in all the studies of mine, but only the first article (section II) applies the exact setup as displayed in Figure C.1[43]. In the other articles (Section III and IV), the 6th level is modified for the purposes of these studies (Figure III.1 in section III.3.1 and Figure IV.1 in section IV.3).

The nesting is implemented into the model by adjusting sets and set mappings accordingly. In addition, the base model incorporated 5 levels of nested CES production functions, hence a 6th level is introduced including the related implementation and calibration, where necessary, of sets, parameters, variables and equations (*Eq. X19-X20*).

	Equation	Number of Equations and Variables	Variable
	Production Block, 6th Level		
(X19)	$FD_{f5ag,a} = AD^{FD}_{f5ag,a} * \left[\sum_{f6\$\delta^{fd}_{f5ag,f6,a}} \left(\delta^{fd}_{f5ag,f6,a} * FD_{f6,a}^{-\rho^{fd}_{f5ag,a}} \right) \right]^{-1/\rho^{fd}_{f5ag,a}}$	(f5ag*a)	$FD_{f5ag,a}$
(X20)	$WF_{f6} * WFDIST_{f6,a} * (1 + TF_{f6,a}) = WF_{f5ag} * WFDIST_{f5ag,a} * (1 + TF_{f5ag,a}) * FD_{f5ag,a} * \left[\sum_{f6\$\delta^{fd}_{f5ag,f6,a}} \left(\delta^{fd}_{f5ag,f6,a} * FD_{f6,a}^{-\rho^{fd}_{f5ag,a}} \right) \right]^{-1} * \delta^{fd}_{f5ag,f6,a} * FD_{f6,a}^{\left(-\rho^{fd}_{f5ag,a}-1\right)}$	(f6*a)	$FD_{f6,a}$

[43] Because of presentational limitations, the last level is not reported in the first article, however elasticities are set very elastic to approximate an aggregated group.

Figure C.1 Value Added Nesting of Original Israeli SAM-Labour Accounts (Section II)



C.2 Migration Function

A migration function is developed and applied in article 2 and article 3 (section III and IV). The purpose of this migration is to model movement between factor types and simultaneously be able to track origin and destination of these migration flows. These bilateral migration flows are used to relate factor movements to different assumptions on productivity, which is implemented on top of the migration block and described in section C.3.

Existing Approaches to Model Migration

As described in section B.2, the base version of STAGE-LAB contains already a block of equation for migration (*M1-M3*). In STAGE-LAB the migration decision is based of a change in the wage rate relative to the average wage change ($AVGWF_{mig}$) in the migration group (mig). Thus the workers migrate to a pool and are distributed out of that pool and assigned to their new factor types. In order to model bilateral migration flows, it would be possible to have only one pair per pool. For the validity of the migration clearing equation (*Eq. M3*), each factor must be assigned only to one migration group. Therefore, only one pool per factor is possible and bilateral migration is only possible between two specific labour types. In addition, technically possible but not nicely modelled, the average wage ($AVGWF_{mig}$) is not calculated by an equation and is mapped to (*Eq. M3*) to maintain the balance between variables and equations.

	Equation	Number of Equations and Variables	Variable
	Migration Block in STAGE-LAB Base Version: Pool Solution		
(M1)	$WFMIG_{f,mig} = \left(\frac{\sum_a \left(WF_f * WFDIST_{f,a} * FD_{f,a}\right)}{\sum_a FD_{f,a}}\right) \Big/ AVGWF_{mig}$	(f*mig)	$WFMIG_{f,mig}$
(M2)	$FS_f = FS0_f * \left(\sum_{mig} \frac{WFMIG_{f,mig}}{WFMIG0_{f,mig}}\right)^{etamig_f}$	f	FS_f
(M3)	$\sum_f FS_f = \sum_f FS0_f \quad \forall\, f\ element\ in\ mig$	mig	$AVGWF_{mig}$

A Bilateral Migration Approach

Thus, a new approach is developed in order to be able to track bilateral migration. This approach is formally depicted in article 2 in section III and explained in more detail in this section. First, labour types which can migrate and groups within which migration is possible need to be defined. In the following example and in the studies, migration occurs within labour types between sector blocks, but the migration framework can easily be applied in other dimensions, e.g., migration between regions or skill-levels.

The 32 factor types of the SAM are in a first step aggregated to 6 factor types:

- Skilled Jewish,
- Skilled Arab and others,
- Unskilled Jewish,
- Unskilled Arab and others,
- Foreigners from ROW and
- Palestinians.

In a second step each of these 6 factor types is separated into different sector blocks. The number of sector blocks can be chosen freely, article 2 (section III) distinguishes 3 sector blocks:

- Agriculture,
- Manufacturing and
- Services.

Article 3 (section IV) distinguishes 5 sector blocks, including additional sector blocks for food products and construction. In the following explanations I will stick to three sector blocks: thus, there are (6*3) sector block specific factor types in the model. Sector block specific factor types which can migrate, are defined by subset *fmig(f)* (and its alias *fmigp*) of factors, these factors can migrate within a migration group, which is specified in a separate mapping set. More specifically, as displayed in Table C.1, the mapping set defines pairs of factors, between which migration is possible, and defines it in both directions, e.g., skilled Jewish agricultural workers migrating to skilled Jewish manufacturing labour and vice versa.

Table C.1. Migration Pairs

	(1) Skilled Jewish	(2) Skilled Arab and Others	(3) Unskilled Jewish	(4) Unskilled Arab and Others	(5) Foreigners from ROW	(6) Palestinians
(I)	Agriculture ↕ Manufacturing	Agriculture ↕ Manufacturing	Agriculture ↕ Manufacturing	Agriculture ↕ Manufacturing	Agriculture ↕ Manufacturing	Agriculture ↕ Manufacturing
(II)	Manufacturing ↕ Services	Manufacturing ↕ Services	Manufacturing ↕ Services	Manufacturing ↕ Services	Manufacturing ↕ Services	Manufacturing ↕ Services
(III)	Services ↕ Agriculture	Services ↕ Agriculture	Services ↕ Agriculture	Services ↕ Agriculture	Services ↕ Agriculture	Services ↕ Agriculture

The migration decision is based on relative wage changes (Eq. M4). An increasing wage of factor *fmigp* relative to factor *fmig* initiates factors to migrate from factor *fmig* to factor *fmigp* ($FSM_{fmig,fmigp}$) inside a specified migration group. The response to migration is governed by the factor specific migration elasticity ($etamig_{fmig}$), which can take values between zero, not including the boundary for technical reasons, and infinity. With a low elasticity, near zero, factors respond only little to relative wage changes, a high elasticity makes factors react sensitive to changes in relative wages. All workers, who belong to a factor, have the possibility to migrate, thus migration is based on factor supply in the base ($FS0_{fmig}$). In the base situation, the relative wage equals the relative wage in the base and there is no migration. It is worth to notice, that workers which stay in their old sector, are depicted as workers from *fmig* remaining in *fmig* ($FSM_{fmig,fmig}$) and the migration function (*Eq. M4*) is only valid for migration pairs, alas, workers migrating from *fmig* to *fmigp*. Furthermore, pairwise migration flows are possible only in one direction, e.g., from skilled Jewish agricultural labour to skilled Jewish manufacturing labour, and must be positive, accordingly, $FSM_{fmig,fmigp}$ is per definition a positive variable. Hence, in the example with 3 sector blocks and 6 factor types which serve as migration groups, the number of equations and variables for the migration function is (6*3), which is the number of pairs between which migration is possible (Table C.1). Wages might differ for the activities a factor is employed in ($WFA_{f,a}=WFDIST_{f,a}*WF_f$), thus, relative wages are defined by weighted average wage rates of the factor.

	Equation	Number of Equations and Variables	Variable
	Bilateral Migration Block		
(M4)	$FSM_{fmig,\,fmigp} = FS0_{fmig} * \left[\frac{relative\ wage_{fmigp,fmig}}{relative\ wage\ in\ the\ base_{fmigp,fmig}}\right]^{etamig_{fmig}} - FS0_{fmig}$ $\forall\ fmigp\ \neq fmig\ AND\ fmigp \in migration\ group$ $FSM_{fmig,\,fmigp} \geq 0$ $relative\ wage_{fmig,fmigp} = \left(\frac{\sum_a WFA_{fmigp,a} * FD_{fmigp,a}}{\sum_a FD_{fmigp,a}}\right) \Big/ \left(\frac{\sum_a WFA_{fmig,a} * FD_{fmig,a}}{\sum_a FD_{fmig,a}}\right)$	Number of migration pairs	$FSM_{fmig,fmigp}$
(M5)	$FS0_{fmig} = \sum_{fmigp} FSM_{fmig,fmigp}$	fmig	$FSM_{fmig,fmig}$
(M6)	$FS_{fmig} = \sum_{fmigp} FSM_{fmigp,fmig}$	fmig	FS_{fmig}

Translated to a matrix of origin and destination factor groups, there are only diagonal entries in the base situation. Table C.2 exemplarily displays migration for one factor type (e.g., skilled Jewish labour): in the base the amount of workers in a factor type equals the base factor supply ($FSM_{agr,agr}=FS.l_{agr}=FS0_{agr}$). When relative wages change in a simulation, bilateral factor migration occurs, this is induced by equation M4. Table C.2 shows this exemplarily, assuming increasing wages in manufacturing and services. The amount of workers who migrate from a factor and those who remain in the factor, the sum over columns, must equal the base supply of the factor ($FS0_{fmig}$) (*Eq. M5*) This condition specifies the number of workers who do not migrate ($FSM_{fmig,fmig}$). Finally, the sum over rows gives the new amount of workers in a factor group ($FS.l_{fmig}$).

Table C.2. Bilateral Migration System

Base	Agriculture	Manufacturing	Services	∑
Agriculture	$FSM_{agr,agr}$			$FS0_{agr}$
Manufacturing		$FSM_{man,man}$		$FS0_{man}$
Services			$FSM_{ser,ser}$	$FS0_{ser}$
∑	$FS.L_{agr}$	$FS.L_{man}$	$FS.L_{ser}$	
Simulation	**Agriculture**	**Manufacturing**	**Services**	**∑**
Agriculture	$FSM_{agr,agr}$	$FSM_{agr,man}$	$FSM_{agr,ser}$	$FS0_{agr}$ → constant
Manufacturing		$FSM_{man,man}$		$FS0_{man}$→ constant
Services		$FSM_{ser,man}$	$FSM_{ser,ser}$	$FS0_{ser}$ → constant
∑	$FS.L_{agr}$	$FS.L_{man}$	$FS.L_{ser}$	

C.3 Productivity Adjustment

Factors are assumed homogeneous inside a factor type and heterogeneous between factor types. Based on bilateral migration, the model is modified to allow for a variety of assumptions on factor productivity. For this purpose, in a first step, wages are defined per productivity unit and a sector specific efficiency factor for labour types ($ADFDF_{f,a}$) is implemented to identify productivity differences. In the second step, a variable ($ADFDFADJ_f$) is defined which allows for productivity adjustments for migrating workers, i.e., when assuming factor specific productivity.

A Sector Specific Efficiency Factor for Labour Types ($ADFDF_{f,a}$)

Assuming, that wage differences reflect differences in factor productivity, wages are defined per productivity unit and thus are equalized. Productivity differences are fully incorporated in the newly introduced efficiency factor for factor types ($ADFDF_{f,a}$), thus, variables are defined the following:

- $FD_{f,a} = factor\ demand,\ real\ quantity\ of workers\ demanded\ in\ sector\ a$
- $ADFD_{f,a} = shift\ parameter\ for\ factor\ and\ activity\ specific\ efficiency$
- $ADFDF_{f,a} = efficiency\ factor\ for\ factors$
- $FD_{f,a} * ADFDF_{f,a} = productivity\ unit$
- $WF_f * WFDIST_{f,a} = productivity\ unit\ wage\ in\ sector\ a$
- $WF_f * WFDIST_{f,a} * ADFDF_{f,a} = wage\ of\ one\ worker\ in\ sector\ a$

And

$$WF_f * WFDIST_{f,a} = \frac{TV_{f,a}}{FD_{f,a} * ADFDF_{f,a}}$$

[Wage of productivity unit] = [Transaction value per productivity unit]

Following the new definition of variables, the calibration of parameters is adjusted, which are used for the initialisation of these variables. It is possible to calibrate wage rate and efficiency factors in two ways:

- Version I: sector specific productivity
    - $WF0_f = \sum_a (SAM_{f,a}) / FS0_f$
    - $ADFDF0_{f,a} = 1.0$
    - $WFDIST0_{f,a} = \frac{(SAM_{f,a}/FD0_{f,a})}{WF0_f}$
- Version II: factor specific productivity
    - $ADFDF0_{f,a} = SAM_{f,a}/FD0_{f,a}$
    - $WF0_f = \sum_a (SAM_{f,a}) / \sum_a (FD0_{f,a} * ADFDF0_{f,a})$
    - $WFDIST0_{f,a} = 1.0$
- $ADFDF0_{fag,a} = 1.0$ and $ADFDF.fx_{fag,a} = ADFDF0_{fag,a}$[44]

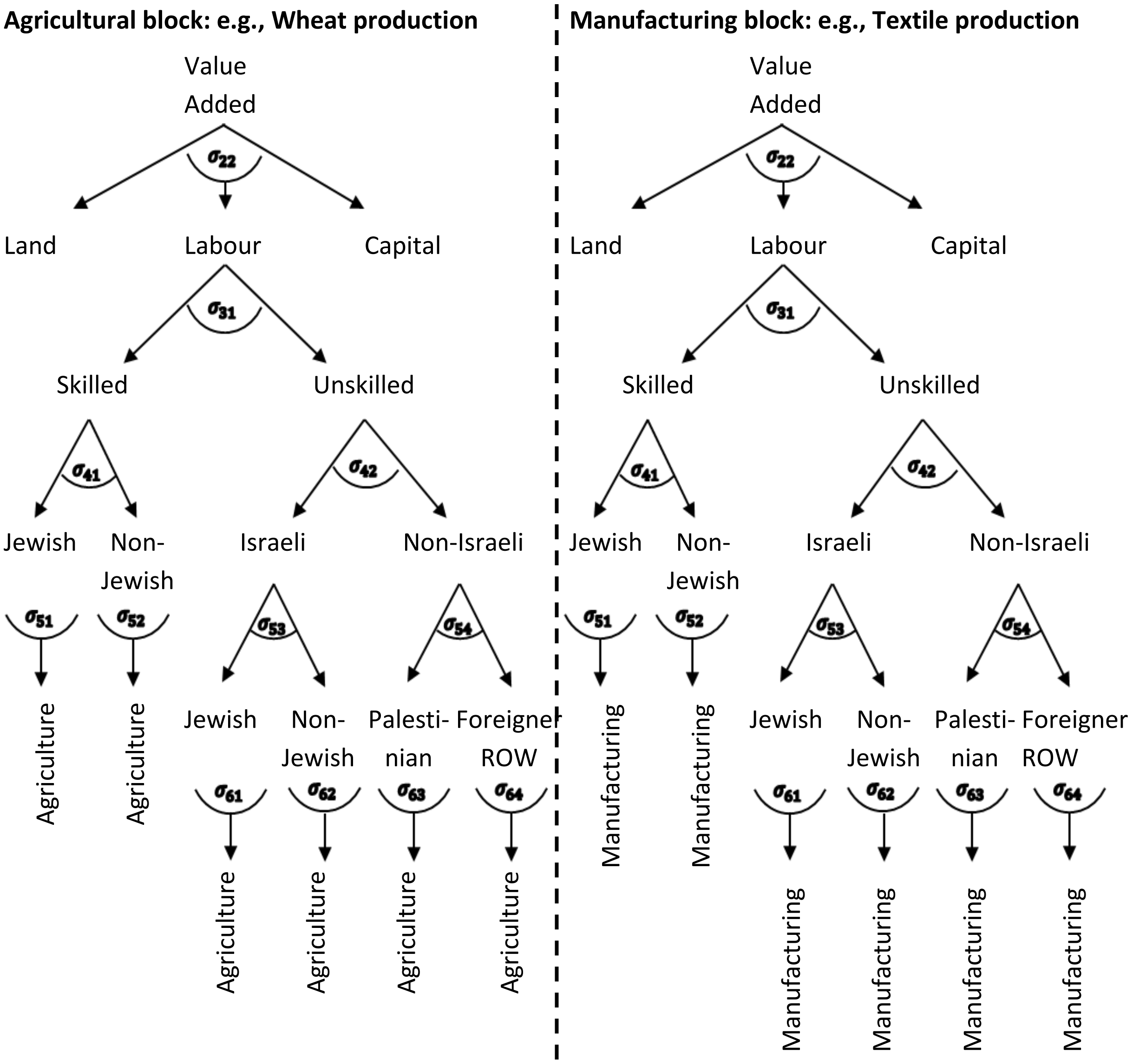
At this stage, it does not matter for results whether Version I or Version II is employed, unless there is no adjustment of the productivity taking place. Choosing $ADFDF_{f,a}$ as the productivity variable is thus a matter of interpretation: the sectoral proportion for factor prices, $WFDIST_{f,a}$, connects productivity differences to activities, while $ADFDF_{f,a}$ connects productivity to factors. If $ADFDF_{f,a}$ is calibrated as in version II, the adjustment of the productivity takes place on the real factors' level, and the upper/aggregated level adjusts accordingly. On the aggregated level it is not relevant whether $WFDIST_{fag,a}$ or $ADFDF_{fag,a}$ adjusts and $ADFDF_{fag,a}$ are fixed to its base levels.

Because wages are defined per productivity unit, factor demand needs to be transferred into factor demand per productivity unit ($FD_{f,a}$*$ADFDF_{f,a}$) throughout the model. Accordingly, the efficiency factor is also implemented in the production functions: Value added (QVA_a) is the result of employing productivity units, when one worker is double as productive as a second worker the output he produces is double as much. *Equation X14a* shows the new production function and *equation X15a* the corresponding first order condition for profit maximization, the new element is indicated by bold letters. Production functions on other levels of the nesting structure are adjusted similarly.

In article 2 and article 3, labour types are aggregated and there is no differentiation between gender and occupation, the six remaining labour types are split by sector block. Thus the base structure of the production nest remains the same, but since each activity only employs the related sector block specific factor types there is no possibility to substitute between the sector blocks (Figure C.3). Accordingly substitution elasticities of the last nest of each branch in the nesting structure are without effect.

[44] On the aggregated level, productivity differences are caught by $WFDIST_{fag,a}$ again (and only by it), which is flexible. WF_{fag} is fixed, too.

Figure C.2: Value Added Nest with Sector Block Specific Labour Types



	Equation	Number of Equations and Variables	Variable
	Production Block, Second Level, Productivity Unit Calibration, *(3rd, 4th and 5th level are analogue)*		
(X14a)	$QVA_a = AD_a^{va} * \left[\sum_{f2\$\delta_{f2,a}^{va}} \left(\delta_{f2,a}^{va} * \left(\boldsymbol{ADFDF_{f2,a}} * FD_{f2,a} \right)^{-\rho_a^{va}} \right) \right]^{-1/\rho_a^{va}}$	A	QVA_a
(X15a)	$WF_{f2} * WFDIST_{f2,a} * (1 + TF_{f2,a}) = PVA_a * QVA_a * AD_a^{va} * \left[\sum_{f2\$\delta_{f2,a}^{va}} \left(\boldsymbol{ADFDF_{f2,a}} * FD_{f2,a} \right)^{-\rho_a^{va}} \right]^{-1} * \delta_{f2,a}^{va} * \left(\boldsymbol{ADFDF_{f2,a}} * FD_{f2,a} \right)^{-\rho_a^{va}-1}$	(f2*a)	$FD_{f2,a}$

Implementation of a Productivity Adjustment for Migrating Workers

When a factor moves between sectors or factor types, the factor is typically assumed to gain the productivity of the destination sector or factor type, thus, productivity is assumed sector specific[45]. In order to make productivity factor specific, which means that a factor keeps its old productivity in the destination, a productivity adjuster is implemented. With this adjuster, productivity adjusts endogenously in combination with the migration function.

The base idea is, that a migrating factor ($FSM_{f,fp}$) maintains its old productivity and the average productivity of the new sector block (ADF_f) adjusts accordingly.

Migration is recorded factor group specific, we know the factor origin of each migrating factor, but not the exact activity (factors are homogeneous inside a factor group). The adjustment factor is therefore not activity specific, but sector block specific – unless a factor group represents only one activity. It is not possible to track the exact origin of the migrants of an activity, therefore workers are assumed to migrate in fixed shares to each activity which demands new labour.

In case there is one factor type for each single activity, with factor specific productivity, the productivity of a factor type where in-migration occurs is determined as follows

$$ADFDF_{f1,a1} = \frac{ADFDF0_{f1,a1} * FD0_{f1,a1} + ADFDF0_{f2,a2} * FSM_{f2,f1} + ADFDF0_{f3,a3} * FSM_{f3,f1}}{FD_{f1,a1}}$$

or generalised

[45] The wording can cause some confusion: a factor moves from one factor type to another factor type which has its own productivity. The factor type has its productivity from employment in specific sectors and is therefore sector specific. Hence, when a factor migrates to another factor type and takes on the productivity of the destination factor type, it gets the productivity from employment in a new sector (even though it is also related to a specific factor type).

$$ADFDF_{fmig,a} = \frac{ADFDF0_{fmig,a}*FD0_{fmig,a}+\sum_{fmigp,ap} ADFDF0_{fmigp,ap}*FSM_{fmigp,fmig}}{FD_{fmig,a}}$$

When there are several activities per factor group, there are three points to deal with, exemplarily depicted in Figure C.4:

1. Factors can move between factor types (f2 to f1) and also inside a factor between two activities (f1 from a1 to a2). It is possible to track movement between factor groups, but not between the actual activities inside a factor type. The change in FD includes both: movement inside a factor group and between factor groups.
2. We do not know where the worker from a3 and the worker from a4 are going to, a1, a2 or a5. We therefore move workers with the 'average productivity' of their factor group.
3. We only know the total amount of f2 migrating to f1 and f3, not which activity absorbs them actually, first, because workers can move inside a factor, from a1 to a2. Second, if a factor absorbs migrants from more than one factor, we do not know which activity absorbs which factor. Each sector is therefore assumed to receive the same share of 'migrants'. The Productivity is adjusted in all activities of a factor group with the same adjustment factor.

Figure C.3 Schematic Depiction of Migration Flows with Three Factor Types and Six Activities

	a1	a2	a3	a4	a5	a6
f1	X	X				
f2			X	X		
f3					X	X

Average factor specific productivity of a factor type ($ADF0_f$) is calculated as weighted average from activity specific efficiency factors:

$$ADF0_{f1} = \frac{\sum_a FD0_{f1,a}*ADFDF0_{f1,a}}{\sum_a FD0_{f1,a}}$$

The level of the productivity of factor type f1 is determined by the amount of workers remaining in factor type 1 and the amount of workers migrating to factor type 1, which keep their former factor type's productivity:

$$ADF_{f1} * FS_{f1} = ADF0_{f1} * FSM_{f1,f1} + ADF0_{f2} * FSM_{f2,f1} + ADF0_{f3} * FSM_{f3,f1}$$

Thus, translated to the activity specific efficiency factor ($ADFDF_{f,a}$), the actual productivity is determined by the old productivity ($ADFDF0_{f,a}$) and a factor type specific productivity adjustment factor ($ADFDFADI_f$).

	Equation	Number of Equations and Variables	Variable
	Productivity Block		
(PA1)	$ADFDF_{f,a} = ADFDF0_{f,a} * ADFDFADJ_f$	(f*a)	$ADFDF_{f,a}$
	where		
(PA2)	$ADFDFADJ_f = \frac{\sum_{fp} ADF0_{fp} * FSM_{fp,f} * adfadj_{fp}}{ADF0_f * FS_f}$	f	$ADFDFADJ_f$
	When there is only one activity per factor, then		
	$ADF0_{f1} = ADFDF0_{f1,a}$		

With this setup, productivity can be set factor specific or alternatively sector specific for each factor type separately. When $ADFDFADJ_f$ is fixed to its base value, $ADFDF_{f,a}$ does not change (*Eq. PA1*), a migrating factor takes on the productivity in the destination factor type and productivity is sector specific. When $AFDFADJ_{f,a}$ is flexible and thus equation (*Eq. PA2*) is active, productivity is factor specific and a migrating worker adjusts the productivity in its destination factor type. An additional adjustment parameter, $adfadj_{fp}$, is implemented to allow for variation in the skill transfer. If the adjustment parameter, $adfadj_{fp}$, is set to a value less than 1, the worker cannot maintain his former level of income. When it equals 1, the worker maintains his old productivity; if it is greater than 1, productivity increases.

Productivity adjustments occur only on the destination factor type. This is based on the assumption, that migrants are factors with average and not marginal productivity. On the one hand, it is reasonable to argue, that the best workers are the first to migrate because they have also the best opportunities to adapt to a new labour type (e.g., a higher skill level or sector to work). Then migration should decrease productivity in the old sector of work and effect positively the destination labour type accordingly. On the other hand, it is also reasonable to argue, that a firm which decreases employment first gets rid of the least productive workers or workers choose to change their situation which are least appropriate for the job. Most apparent is this argument with regard to capital, where an investor would definitely start to reallocate first the least productive capital. With this assumption, migration should increase productivity in the old sector of employment and negatively influence the destination factor type. Both arguments are reasonable and there is a lack of empirical evidence which could give the preference to one argument. When the factor is assumed to migrate with the average productivity, it is therefore assumed that both types of factors migrate, the highest and the least productive workers, which in sum statute an average factor.

This section describes extreme assumptions: productivity is either fully factor specific or fully sector specific. However, it is possible to choose a less extreme setup, where a part of the productivity is sector and another part is factor specific. For this purpose, $WFDIST_{f,a}$ and $ADFDF_{f,a}$ are calibrated to contain both a part of the productivity. $WFDIST_{f,a}$ then displays the sector specific productivity while $ADFDF_{f,a}$ accounts for the factor specific part.

Thus, there are four possibilities to depict productivity or skill transfer of inter-industry labour reallocation:

- Reallocated labour adopts the new sector's productivity. ($ADFDF_f$ is fixed)
- Reallocated labour retains the old sector's productivity. Thus, the average productivity of each labour type in each sector block will change. ($ADFDF_f$ is flexible)
- Reallocated labour retains the old sector's productivity adjusted for a predetermined productivity change ($adfadj_{fp}$,not equal to 1).
- Reallocated labour adopts a productivity somewhere between that of the old and new sectors. Again, the average productivity of each labour type in each sector block will change. For this purpose, productivity is set partly sector and partly factor specific in model calibration.

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